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NAPA VALLEY SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

Section 5 – Monitoring Network and Programs

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NOTE: Highlighted text present in this draft will be updated as subsequent Sections and related material are developed, prior to release of the of the complete draft GSP.

5. MONITORING NETWORK AND PROGRAM (§ 354.34, § 354.38, AND § 352.2)

Pursuant to Groundwater Sustainability Plan (GSP) Regulations §354.34, this section describes the monitoring networks that have been developed for the Napa Valley Subbasin, including monitoring objectives, monitoring protocols, data reporting requirements, and planned monitoring network expansion. The monitoring networks promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan. The section describes existing groundwater and surface water monitoring networks and how the monitoring networks will be refined and expanded during Plan implementation to track groundwater and surface water conditions. The monitoring networks and programs described in this section are required by SGMA to collect sufficient data to determine short-term, seasonal, and long-term trends for the six sustainability indicators, including:

1. Groundwater levels
2. Groundwater storage
3. Seawater intrusion
4. Water Quality
5. Land subsidence
6. Interconnected surface water and groundwater

Additional monitoring networks are described in this section that the Napa County Groundwater Sustainability Agency (NCGSA) considers valuable in assessing the conditions of the Subbasin and efficacy of the monitoring networks for each sustainability indicator.

This section is organized to describe the objective for each monitoring network, the requirements and monitoring protocols, a description of the current monitoring network, rationale for monitoring, an assessment of the monitoring network's ability to collect sufficient data to characterize conditions within the Subbasin, data gaps within the monitoring network, and actions the NCGSA will take to address the data gaps. **Table 5-1** summarizes the GSP Regulations relevant to GSP monitoring networks and the section in which they are addressed within this Plan.

Table 5-1: Groundwater Sustainability Plan Regulations- Monitoring Network and Program

GSP Regulations Reference[1]	Required Component Summary	Corresponding Plan Contents

§352.2	Monitoring protocols adopted by the Agency for data collection and management	Section 5.4.2; 5.5.2; 5.6.2; 5.7.1.2; 5.7.2.2; 5.8.2; 5.9.2; 5.10.2; 5.11.2
§354.32	A descriptive of the monitoring network…including monitoring objectives, monitoring protocols, and data reporting requirements.	Section 5.1:5.11
§354.34(a)	Descriptive of how the monitoring network is capable of collecting representative information about groundwater conditions as necessary to evaluate Plan implementation.	Section 5.4; 5.5; 5.6; 5.7; 5.8; 5.9; 5.10; 5.11
§354.34(b)(1)	Monitoring network demonstrates progress toward achieving measurable objectives described in the Plan.	Section 5.4; 5.5; 5.6; 5.7.1; 5.7.2; 5.8; 5.9; 5.10; 5.11
§354.34(b)(2)	Monitoring network capability to monitor the impacts to the beneficial uses or users of groundwater.	Section 5.3
§354.34(b)(3)	Monitoring network monitors changes in groundwater conditions relative to measurable objectives and minimum thresholds.	Section 5.4; 5.5; 5.6; 5.7.1; 5.8; 5.9
§354.34(b)(4)	Monitoring network implemented to quantify annual changes in water budget components.	Section 5.5
§354.34(c)(1)	Monitoring network demonstrates groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods	Section 5.4
§354.34(c)(2)	Monitoring network is able to provide an estimate of the change in annual groundwater in storage.	Section 5.5
§354.34(c)(3)	Monitoring network is able to track chloride concentrations, or other measurements convertible to chloride concentrations.	Section 5.6
§354.34(c)(4)	Monitoring network collects spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends.	Section 5.7
§354.34(c)(5)	Monitoring network is sufficient to provide the rate and extent of land subsidence	Section 5.8
§354.34(c)(6)	Monitoring of surface water and groundwater, where interconnected surface water conditions exist.	Section 5.9
§354.34(d)	The monitoring network ensures adequate coverage of sustainability indicators over the Plan area and in management areas.	Section 5.4.3-5.4.6; 5.5.3-5.5.6; 5.6.3-5.6.6; 5.7.1.3-5.7.1.6; 5.7.2.3-5.7.2.6; 5.8.3-5.8.6; 5.9.3-5.9.6; 5.10.3-5.10.6, 5.11.3-5.11.6
§354.34(e)	Monitoring networks utilize site information and monitoring data from existing sources.	Section 5.4.3; 5.5.3; 5.6.3; 5.7.1.3; 5.7.2.3; 5.8.3; 5.9.3; 5.10.3, 5.11.3
§354.34(f)(1)	The density of monitoring sites and frequency of measurements to demonstrate trends based upon current and projected groundwater use.	Section 5.5.3
§354.34(f)(2)	The density of monitoring sites and frequency of measurements to demonstrate trends based upon aquifer characteristics.	Section 5.4.2; 5.5.2; 5.6.2;5.7.1.2; 5.9.2

§354.34(f)(3)	The density of monitoring sites and frequency of measurements to demonstrate trends based upon the impacts to beneficial uses and users of groundwater and land uses.	Section 5.4.3-5.4.6; 5.5.3-5.5.6; 5.6.3-5.6.6; 5.7.1.3-5.7.1.6; 5.7.2.3-5.7.2.6; 5.8.3-5.8.6; 5.9.3-5.9.6; 5.10.3-5.10.6, 5.11.3-5.11.6
§354.34(f)(4)	The density of monitoring sites and frequency of measurements to demonstrate trends based upon whether there is adequate existing monitoring data.	Section 5.4.5; 5.5.5; 5.6.5; 5.7.1.5; 5.7.2.5; 5.8.5; 5.9.5, 5.10.5; 5.11.5
§354.34(g)(1)	Scientific rationale for the monitoring site selection process.	Section 5.4.3-5.4.6; 5.5.3-5.5.6; 5.6.3-5.6.6; 5.7.1.3-5.7.1.6; 5.7.2.3-5.7.2.6; 5.8.3-5.8.6; 5.9.3-5.9.6; 5.10.3-5.10.6; 5.11.3-5.11.6
§354.34(g)(2)	Consistency with data and reporting standards	Section 5.4.1-5.4.2; 5.5.1-5.5.2; 5.6.1-5.6.2; 5.7.1.1-5.7.1.2; 5.7.2.1-5.7.2.2; 5.8.1-5.8.2; 5.9.1-5.9.2; 5.10.1-5.10.2; 5.11.1-5.11.2
§354.34(g)(3)	Quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites.	Addressed in Section 9
§354.34(h)	Map and table of monitoring site locations and additional site information.	Figure 5-1; Figure 5-3:Figure 5-10 Table 5-3; Table 5-5; Table 5-6; Table 5-8; Table 5-10; Table 5-11; Table 5-13; Table 5-15; Table 5-16
§354.34(i)	Technical standards, data collection methods, and other procedures or protocols for monitoring data collection.	5.4.2; 5.5.2; 5.6.2; 5.7.1.2; 5.7.2.2; 5.8.2; 5.9.2; 5.10.2; 5.11.2
§354.34(j)	Demonstration that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin.	N/A
§354.38(b)	Assessment of monitoring network and include an evaluation in the Plan and each five-year assessment	Section 5.4.4; 5.5.4; 5.6.4; 5.7.1.4; 5.7.2.4; 5.8.4; 5.9.4; 5.10.4; 5.11.4
§354.38(b)	Identification of data gaps wherever the Subbasin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable.	Section 5.4.5; 5.5.5; 5.6.5; 5.7.1.5; 5.7.2.5; 5.8.5; 5.9.5; 5.10.5; 5.11.5
§354.38(c)	If data gaps exist, description of the location and reason for data gap or local issues/circumstances that limit or prevent monitoring.	Section 5.4.5; 5.5.5; 5.6.5; 5.7.1.5; 5.7.2.5; 5.8.5; 5.9.5; 5.10.5; 5.11.5
§354.38(d)	Description of the steps that will be taken to fill data gaps before the next five-year assessment.	Section 5.4.6; 5.5.6; 5.6.6; 5.7.1.6; 5.7.2.6; 5.8.6; 5.9.6; 5.10.6; 5.11.6
§354.38(e)	Description of the changes to be made in monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions.	Section 5.4.6; 5.5.6; 5.6.6; 5.7.1.6; 5.7.2.6; 5.8.6; 5.9.6; 5.10.6; 5.11.6

1. The GSP Regulations are published in Title 23 of the California Code of Regulations.

5.1. Overview

The monitoring networks for the Napa Valley Subbasin build on data collection efforts underway since the early twentieth century by federal, state, and local public agencies. This section describes the monitoring networks for the Subbasin that will "promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan" (GSP Regulations §354.34 (a)).

The monitoring networks described in this section are developed from existing monitoring sites and operated by several monitoring entities, including: 1) Napa County; 2) California Department of Water Resources (DWR); 3) U.S. Geological Survey (USGS); 4) California State Water Resources Control Board (SWRCB); 5) National Geodetic Survey (NGS); and 6) University UNAVSTAR Consortium (UNAVCO). Utilizing data collected from the monitoring networks, **Section 6** of the Plan describes the historical and current groundwater and surface water conditions of the Napa Valley Subbasin. For information regarding Napa County's past groundwater monitoring efforts, refer to **Appendix 5A** and **5B**. NCGSA will evaluate the adequacy of the monitoring networks every five-years to assure adequate details regarding site-specific surface water and groundwater conditions are captured within the networks.

Select sites from the monitoring networks described in this section are designated in **Section 9** as representative monitoring sites. Representative monitoring sites are a subset of the Subbasin's total monitoring network that are specifically selected to track the sustainability indicators using quantifiable measures, called Minimum Thresholds and Measurable Objectives. For detailed information regarding the Subbasin's representative monitoring network refer to **Section 9**.

5.2. Objectives

The monitoring networks described in this section are important in that they allow for the detection of hydrologic changes in the Subbasin, track sustainability criterion, and provide the NCGSA with scientific data to support adaptive management to meet the sustainability goal for the Napa Valley Subbasin. Monitoring is an integral component of planning to meet the future demands of all beneficial uses and users of groundwater, therefore, the NCGSA strives to implement monitoring throughout the Subbasin and at key locations where feasible.

The primary objective of the monitoring networks described in this section are to provide sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation and to provide sufficient data that characterizes groundwater and surface water conditions within the Plan area. Where a monitoring network is determined by the NCGSA to have shortcomings in achieving this objective, the NCGSA outlines proposed actions to fulfill the identified deficiencies. Additionally, the monitoring networks described in this section were developed specifically to meet the following objectives, in accordance with GSP Regulations §354.34:

1. Demonstrate progress toward achieving measurable objectives described in the Plan.
2. Monitor impacts to the beneficial uses or users of groundwater.
3. Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
4. Quantify annual changes in water budget components.

5.3. Monitoring Potential Impacts to Beneficial Uses and Users of Groundwater

Described in Section 3 of this GSP, beneficial users of groundwater within the Plan area include private landowners, municipal well operators and public water systems, local land use and planning agencies, environmental users of groundwater, surface water users, and disadvantaged communities. These beneficial users are either direct users of groundwater or are indirectly affected by changing groundwater conditions. The NCGSA's monitoring networks described in this section are designed to detect any potential impacts to the beneficial users of groundwater so that the Agency can respond with the necessary projects and management actions to mitigate and prevent undesirable results. Examples of potential impacts to be avoided are summarized in **Table 5-2**, which also notes the monitoring network essential to addressing each impact. Where a monitoring network is determined to be inadequate in assessing the potential impacts to any of the beneficial users, the NCGSA seeks to address the deficiency through increasing the spatial coverage or monitoring frequency, or both.

Table 5-2: Monitoring Potential Impacts to Beneficial Uses and Users of Groundwater in the Napa Valley Subbasin

Examples of Potential Impacts to Beneficial Uses and Users	Relevant Monitoring Network
Groundwater levels decline, resulting in increased pumping cost or dry wells	Groundwater Level Monitoring
Groundwater storage is depleted, resulting in insufficient water supplies for the future	Groundwater Storage Monitoring
Seawater intrusion progresses into Subbasin, resulting in degraded groundwater quality	Seawater Intrusion Monitoring
Groundwater quality is degraded, resulting in unsuitable water without additional treatment costs	Groundwater Quality Monitoring
Surface water quality is degraded, potentially resulting in degraded groundwater quality in areas where a known connection between surface water and groundwater exist	Surface Water Quality Monitoring
Land subsidence resulting in loss of available groundwater in storage and damage to infrastructure	Land Subsidence Monitoring
Extensive groundwater pumping resulting in depletion of surface waters	Interconnected Surface Water – Groundwater Monitoring
Extensive groundwater pumping resulting in depletion of surface waters, loss or damage to health of groundwater dependent ecosystems (GDE), or loss of public recreational areas	Stream Stage and Stream Discharge Monitoring

Extensive groundwater pumping resulting in loss or damage to health of GDEs	GDE Monitoring Network

5.4. Groundwater Levels

Groundwater level monitoring within the Subbasin is conducted through a groundwater monitoring network that includes both dedicated monitoring wells owned by Napa County and privately owned domestic and agricultural wells. The objectives of the groundwater level monitoring network for the Napa Valley Subbasin include the following:

- Improve the understanding of the occurrence and movement of groundwater; monitor local and regional groundwater levels including seasonal and long-term trends; and identify vertical hydraulic head differences in the aquifer system and aquifer-specific groundwater conditions, especially in areas where short-term and long-term development of groundwater resources are planned;
- Detect the occurrence of, and factors attributable to, natural recharge (e.g., direct infiltration of precipitation), irrigation, and surface water seepage to groundwater or recharge projects and management actions (recharge basins, aquifer storage and recovery) that affect groundwater levels and trends;
- Identify appropriate monitoring sites to further evaluate groundwater-surface water interaction, and recharge/discharge mechanisms, including whether groundwater utilization is affecting surface water flows;
- Establish a monitoring network to aid in the assessment of changes in groundwater storage; and
- Generate data to better estimate groundwater basin conditions and assess local current and future water supply availability and reliability; update analyses, including the groundwater model and water budget, as additional data become available.

5.4.1. Requirements

A groundwater monitoring network should be dense enough to sufficiently represent the lateral and vertical extents of groundwater levels and trends typical of the overall groundwater basin. Additionally, monitoring of groundwater levels should be sufficient to characterize the overall static groundwater conditions and should sufficiently support the evaluation of impacts from implemented GSP projects and management. In accordance with GSP Regulations §354.34, the groundwater level monitoring network must demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:

1) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
2) Static groundwater elevation measurements must be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

In order to assist local agencies with the preparation of GSPs, the California Department of Water Resources (DWR) released a series of best management practices (BMPs) for monitoring protocols and monitoring networks (DWR, 2016a and DWR, 2016b). The BMPs document for monitoring networks provides guidance on determining an appropriate number of monitoring wells. The Monitoring Network and Identification of Data Gaps BMP documentation by DWR (2016b) states no definitive rule for the density of groundwater level monitoring sites needed for a basin, however, provides guidelines adopted from the California Statewide Groundwater Elevation Monitoring (CASGEM) Groundwater Elevation Monitoring Guidelines (DWR, 2010). The monitoring network is recommended to utilize dedicated groundwater monitoring wells, if possible, however, existing monitoring networks may be used so long as existing sites are not influenced by nearby pumping and measurements are taken cautiously to ensure static water levels prior to data measurement. In the Northeast Napa Management Area, described in detail in **Section 9**, the quantity and density of monitoring sites must be sufficient to evaluate conditions of the Subbasin setting and sustainable management criteria specific to that area.

Monitoring sites included in the groundwater level network must also include the following information, in accordance with GSP Regulations §352.4(a) through (c):

- A unique site identification number and narrative description of the site location;
- A description of the type of monitoring, type of measurement taken, and monitoring frequency;
- Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83;
- Elevation of the ground surface, measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described, and identification and description of the reference point;
- A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described;
- CASGEM well identification number. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by the Department, as described in GSP Regulations §353.2;
- A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well;
- Casing perforations, borehole depth, and total well depth;
- Well completion reports, if available, from which the names of private owners have been redacted;
- Geophysical logs, well construction diagrams, or other relevant information, if available;
- Identification of principal aquifers monitored;

- Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

5.4.2. Monitoring Protocols

The monitoring protocols described below include both actions required under GSP Regulations and those recommended in DWR's BMPs. Reporting standards in this section set forth consistent standards in recording groundwater levels. Where a site is not consistent with the standards outlined in this section, a description of the site's necessity to the monitoring network and how variation from the standards will not affect the results should be provided.

- Consistency with data and reporting standards described in §352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.
- The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.
- The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
- A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

5.4.2.1. Methodology

According to Monitoring Protocols, Standards, and Sites BMPs by DWR (2016a), groundwater level monitoring should ensure the following:

- Groundwater level data are taken from the correct location, well ID, screen interval depth, and measured from the correct reference point elevation (RPE) (accurate to within 0.5 feet) relative to the NAVD 88 datum.
- Groundwater level data are accurate and reproducible, measured using the approved measurement equipment that is maintained in accordance with the manufacturer's instructions.
    - Manual measurements should be recorded to the nearest 0.1 foot and should be measured to maintain data logger integrity. Additionally, the water level meter should be decontaminated after measuring each well.
    - The groundwater elevation should be calculated using the following equation.

$$GWE = RPE - DTW$$

Where:

GWE = Groundwater Elevation in NAVD88 datum

RPE = Reference Point (RP) Elevation in NAVD88 datum
DTW = Depth to Water'

  - The measurements of depth to water should be consistent in decimal units of feet, to an accuracy of tenths of feet or hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.
  - Pressure transducers should be installed, operated, and maintained in accordance with the manufacturer's instruction. The well ID, serial number, range, accuracy, and type (vented or non-vented) should be recorded, in which non-vented transducers must be corrected for barometric pressure with continuous data from a barometric transducer.
  - For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.
- Information recorded at each site visit should include:
  - Well ID
  - Data and time (24-hour format)
  - Field staff name
  - Well site RPE and height of reference point relative to groundwater surface at time of measurement
  - Measured depth to groundwater (DTW), in which groundwater elevation (GWE) is calculated from DTW and RPE
  - Comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. Standardized field forms should be used for all data collection.
- The well caps or plugs should be secured following depth to water measurement.
- The sampler should have a record of previous measurements in the field for each well to compare with the current measurements being recorded. If a current measurement appears anomalous compared to previous measurements it should be checked again and verified.

- All data should be entered into the GSA data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person.

The following procedures will be followed in the installation of a pressure transducer and periodic data downloads:

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.
- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment will be exercised to ensure that the data being collected is meeting the Data Quality Objectives (DQO) and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.
- The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually to maintain data integrity.
- The data should be downloaded as necessary to ensure no data is lost and entered into the basin's DMS following the quality assurance/quality control (QA/QC) program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

5.4.2.2. Frequency

In accordance with GSP Regulations §354.34(c)(1)(B), static groundwater elevation measurements must be collected at least two times per year to represent seasonal low and seasonal high groundwater conditions. According to DWR's Groundwater Monitoring Protocols, Standards, and Sites BMP, groundwater levels are preferably collected within a 1 to 2-week period during the middle of October and March.

5.4.3. Monitoring Network

The Napa Valley Subbasin groundwater level monitoring network includes 56 existing wells currently monitored by Napa County, CASGEM, and DWR. Data collected from the groundwater level monitoring network are used to evaluate groundwater occurrence, groundwater flow directions, and hydraulic gradients in the principal aquifers of the Napa Valley Subbasin. **Figure 5-1** shows the locations of wells in the groundwater level monitoring network and **Table 5-3** summarizes relevant well information.

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Table 5-3: Napa Valley Subbasin Groundwater Level Monitoring Network Well Information

Well ID	CASGEM ID	Well Type	Latitude	Longitude	Aquifer	Well Depth (ft bgs*)	Top of Screen (ft bgs*)	Bottom of Screen (ft bgs*)	Period of Record	Monitoring Frequency	Monitoring Entity
06N04W17A001M	383721N1223189W001	Domestic	38.3721	-122.3189	Qa	250			1949 - 2019	Monthly	DWR
06N04W27L002M	383359N1222916W001	Domestic	38.3359	-122.2916	Qa	120	60	120	1966 - 2019	Monthly	DWR
07N05W09Q002M	384635N1224182W001	Unused	38.4635	-122.4182	-	232			1949 - 2019	Monthly	DWR
08N06W10Q001M	385529N1225106W001	Unused	38.5529	-122.5106	-	200			1949 - 2019	Monthly	DWR
NapaCounty-122		Domestic	38.33565	-122.2744722	Tss	210	60	150	2001 - 2019	Semi-Annual	Napa County
NapaCounty-125	383769N1223065W001	Domestic	38.3769	-122.3065	Tsva	160	63	160	1979 - 2019	Semi-Annual	Napa County
NapaCounty-126	383770N1223067W001	Domestic/ Irrigation	38.377	-122.3067	Tsva	345	140	345	1984 - 2019	Semi-Annual	Napa County
NapaCounty-127	385926N1225938W001	Domestic	38.593241	-122.592484	-	149			1962 - 2019	Semi-Annual	Napa County
NapaCounty-128	385791N1225636W001	Unused	38.579352	-122.563038	Qa	50			1962 - 2019	Monthly	Napa County
NapaCounty-129	385725N1225709W001	Domestic	38.571574	-122.568316	-	253			1962 - 2019	Semi-Annual	Napa County
NapaCounty-131	384560N1224223W001	Domestic	38.455743	-122.422479	-	221			1963 - 2019	Semi-Annual	Napa County
NapaCounty-132	384616N1223811W001	Irrigation	38.4616	-122.3811	Qa, Tsvab	265	25	265	1962 - 2019	Monthly	Napa County
NapaCounty-133	384116N1223530W001	Domestic	38.411578	-122.352477	Qa	120	20	120	1978 - 2019	Monthly	Napa County
NapaCounty-134	383948N1223497W001	Irrigation	38.3948	-122.3497	Qa	260	160	260	1963 - 2019	Semi-Annual	Napa County
NapaCounty-135	383554N1223441W001	Irrigation	38.3554	-122.3441	Qa, Tsv	125			1979 - 2019	Monthly	Napa County
NapaCounty-136	383316N1222987W001	Domestic	38.331302	-122.299419	Qa	120	39	120	1979 - 2019	Monthly	Napa County
NapaCounty-138	384518N1224299W001	Domestic/ Irrigation	38.4518	-122.4299	-	321			1949 - 2019	Semi-Annual	Napa County
NapaCounty-139	383603N1223217W001	Domestic	38.360468	-122.320531	Qa	120	40	120	1978 - 2019	Semi-Annual	Napa County
NapaCounty-149		Domestic	38.296	-122.2252	-	340	200	340	2010 - 2019	Semi-Annual	Napa County
NapaCounty-152	383358N1223171W001	Domestic	38.335773	-122.317117	-	104			2012 - 2019	Semi-Annual	Napa County
NapaCounty-169	385000N1224744W001	Domestic	38.5	-122.474434	-	400	60	400	2014 - 2019	Semi-Annual	Napa County
NapaCounty-171		Irrigation	38.495026	-122.462173	Tst/s	438	118	438	2014 - 2019	Monthly	Napa County

NapaCounty-172		Irrigation	38.496385	-122.476271	-	500	80	500	2014 - 2019	Semi-Annual	Napa County
NapaCounty-173		Irrigation	38.498073	-122.475071	-	362			2014 - 2019	Semi-Annual	Napa County
NapaCounty-174		Irrigation	38.500324	-122.47905	-	505	105	505	2014 - 2019	Semi-Annual	Napa County
NapaCounty-177		Unused	38.44879	-122.412071	Qa	123	30	122	2014 - 2019	Semi-Annual	Napa County
NapaCounty-178		Irrigation	38.571133	-122.533691	-				2014 - 2019	Semi-Annual	Napa County
NapaCounty-179	383779N1223342W001	Domestic	38.37794	-122.334177	-	150	30	150	2014 - 2019	Semi-Annual	Napa County
NapaCounty-181		Domestic	38.420774	-122.395621	Tsv	630			2014 - 2019	Semi-Annual	Napa County
NapaCounty-182	383543N1222914W001	Domestic	38.354305	-122.291443	Tsv	400	100	400	2014 - 2019	Monthly	Napa County
NapaCounty-183		Domestic/ Irrigation	38.352626	-122.29732	Qa, Tsv?	310			2014 - 2019	Semi-Annual	Napa County
NapaCounty-184		Irrigation	38.35685	-122.311274	Tsv, Tss/h?	755			2014 - 2019	Semi-Annual	Napa County
NapaCounty-185		Domestic	38.354875	-122.315387	Qa	260	100	260	2014 - 2019	Monthly	Napa County
NapaCounty-187		Domestic	38.335066	-122.344185	Tsv?, KJgv?	630	30	630	2014 - 2019	Semi-Annual	Napa County
NapaCounty-188		Domestic/ Irrigation	38.335833	-122.345173	Tsv, KJgv	540	0	540	2014 - 2019	Semi-Annual	Napa County
NapaCounty-189		Domestic/ Irrigation	38.340193	-122.335153	-	600			2014 - 2019	Semi-Annual	Napa County
NapaCounty-204		Irrigation	38.450245	-122.406113	Qa	220	50	220	2014 - 2019	Semi-Annual	Napa County
NapaCounty-212		Domestic	38.51074	-122.456663	-	273	145	273	2015 - 2019	Semi-Annual	Napa County
NapaCounty-214s-swgw1	383022N1222784W001	Monitoring Well	38.302163	-122.278444	Qa	53	30	50	2014 - 2019	4 hours	Napa County
NapaCounty-215d-swgw1	383022N1222784W002	Monitoring Well	38.302163	-122.278444	Qa	98	75	95	2014 - 2019	4 hours	Napa County
NapaCounty-216s-swgw2	383652N1223375W001	Monitoring Well	38.365159	-122.337464	Qa	50	25	45	2014 - 2019	4 hours	Napa County
NapaCounty-217d-swgw2	383652N1223375W002	Monitoring Well	38.365159	-122.337464	Qa	86	71	81	2014 - 2019	4 hours	Napa County
NapaCounty-218s-swgw3	383674N1223046W001	Monitoring Well	38.367428	-122.304619	Qa	40	25	35	2014 - 2019	4 hours	Napa County
NapaCounty-219d-swgw3	383674N1223046W002	Monitoring Well	38.367428	-122.304619	Qa	93	78	88	2014 - 2019	4 hours	Napa County
NapaCounty-22		Domestic	38.29603804	-122.225197	-	135			2000 - 2019	Semi-Annual	Napa County

NapaCounty-220s-swgw4	384176N1223527W001	Monitoring Well	38.417589	-122.352706	Qa	45	25	40	2014 - 2019	4 hours	Napa County
NapaCounty-221d-swgw4	384176N1223527W002	Monitoring Well	38.417589	-122.352706	Qa	85	70	80	2014 - 2019	4 hours	Napa County
NapaCounty-222s-swgw5	385110N1224564W001	Monitoring Well	38.510951	-122.456379	Qa	40	25	35	2014 - 2019	4 hours	Napa County
NapaCounty-223d-swgw5	385110N1224564W002	Monitoring Well	38.510951	-122.456379	Qa	100	80	95	2014 - 2019	4 hours	Napa County
NapaCounty-224		Domestic	38.547487	-122.50424	-	180	40	180	2014 - 2019	Semi-Annual	Napa County
NapaCounty-225		Domestic	38.545149	-122.5086	-	214	74	214	2014 - 2019	Semi-Annual	Napa County
NapaCounty-227	383411N1223434W001	Domestic	38.341146	-122.343444	-	260	80	260	2015 - 2019	Semi-Annual	Napa County
NapaCounty-229	383457N1222820W001	Domestic	38.345689	-122.282036	Tss	350	180	350	2016 - 2019	Semi-Annual	Napa County
NapaCounty-230	385954N1226201W002	Domestic	38.595407	-122.620087	Tsv	250	70	250	2018 - 2019	Semi-Annual	Napa County
NapaCounty-43	383484N1222702W001	Domestic	38.34832875	-122.2702182	-	310	150	310	2001 - 2019	Semi-Annual	Napa County
NapaCounty-76		Domestic	38.35974845	-122.2829725	Tsv	395	60	395	2000 - 2019	Semi-Annual	Napa County

*ft bgs = feet below ground surface

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Seventeen of the 56 groundwater level monitoring wells have been monitored prior to 2000 and several since the 1940s. Groundwater levels have been regularly monitored by Napa County at 52 sites and by DWR at 4 sites. Thirty-one of the wells monitored by Napa County are reported to the CASGEM Program (including CASGEM Volunteer sites[1]), making up a total of 35 groundwater level monitoring sites that are reported to the CASGEM program. Both Napa County and DWR will continue to monitor wells in the groundwater level monitoring network, assisted by the NCGSA when necessary. The locations of groundwater level monitoring sites in the monitoring network are fairly distributed throughout the Subbasin, considering factors such as data availability, current population, and groundwater utilization (**Section 5.4.4** and **5.4.5**).

Groundwater levels at these well sites are monitored continuously every 4 hours using transducers, monthly, or semi-annual (at least twice a year) schedule. Historically, Napa County has measured the CASGEM wells semi-annually in the spring (April) and the fall (October) of each year. The NCGSA extracts data collected from the remainder of the sites to report the seasonal highs that occur in the spring (typically March through May) and seasonal lows that occur in the fall (typically September through November). In past annual reporting, the seasonal highs and lows have been recorded typically within the 12-week window for spring and fall groundwater levels. Monthly water level monitoring is limited and does not currently provide adequate data to evaluate the effects of hydrologic events or stresses on the aquifer system. In particular, 3 wells are monitored monthly by DWR. These wells are located in the Calistoga, St. Helena, Napa areas, respectively, and are also located generally near the Napa River.

5.4.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitor groundwater levels within the Plan area include:

- Many existing wells have groundwater level monitoring records of at least 20 years
- A majority of the wells have known construction and aquifer completion information
- Groundwater use in surrounding wells in the area is at a minimum
- Spatial and vertical representation of the principal and secondary aquifer units

The overall spatial density of the current groundwater monitoring network is approximately 53 wells per 100 square miles. Wells screened in the principal alluvial aquifer result in a spatial density of 32 wells per 100 square miles, whereas wells screened in secondary volcanic sediments account for a spatial density of approximately 21 wells per 100 square miles. According to DWR BMPs (DWR, 2016b), the current monitoring network satisfies the minimum well density recommended by DWR of 4 wells per 100 square miles for monitoring networks. However, given the complex geologic setting of the Napa Valley Subbasin, the NCGSA wishes to increase monitoring in key areas to better characterize groundwater conditions (see **Section 5.4.6**). In addition to monitoring over the whole Subbasin, there are currently 5 wells in the Northeast Napa Management Area (NEMA) monitored for groundwater levels. The overall spatial density of monitoring in the NEMA compared to monitoring only wells known

[1]Includes private well owners who have volunteered wells for inclusion in the CASGEM program.

to be screened in the secondary volcanic aquifer is approximately 163 wells per 100 square miles and 130 wells per 100 square miles. There are currently no monitoring wells screened within the principal alluvial aquifer in the NEMA.

There are currently 21 wells without designated aquifer information, however, a driller's log is available for all of these wells. Of the 21 wells without a designated aquifer, only one well has unknown well depth and screen information.

Groundwater levels are monitored continuously every 4 hours, monthly, and semi-annually to provide seasonal highs and lows in groundwater elevation, satisfying DWR guidance of monitoring at least twice a year. According to DWR BMPs (2016a), the allocated timeframe for collecting groundwater level measurements from the network is recommended to be within a 1 to 2-week period. Due to the number of monitoring wells in the Subbasin, manual measurements of groundwater levels is more viable if collected within a 3-month window in the fall and spring instead, which has been the typical monitoring schedule for the NCGSA.

DWR recommends utilizing dedicated groundwater monitoring wells, if possible, however, a majority of existing domestic and agriculture wells have been made accessible for monitoring which the Agency utilizes. Of the existing monitoring wells, a majority are either domestic or unused wells, which are generally pumped less than irrigation wells. In addition to already existing wells, the NCGSA constructed 5 dual-completion monitoring sites throughout the Subbasin in 2014, which the Agency will continue to monitor as part of the groundwater level monitoring network.

For every five-year update of the GSP, the NCGSA will include an analysis of the existing monitoring networks and its ability to accurately characterize conditions, updating the network when possible.

5.4.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

The NCGSA has identified data gaps in the groundwater level monitoring network for the Napa Valley Subbasin and has summarized the information in **Table 5-4**.

Table 5-4: Data Gaps in Groundwater Level Monitoring Network

Data Gap Type	Applicable Wells
Insufficient well construction information	NapaCounty-178

5.4.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

In accordance with GSP Regulations §352.4(2), the NCGSA will retrieve the necessary construction information for the single groundwater level monitoring well (Napa County-178) currently lacking this information. If construction data are not documented, a downhole well survey will be utilized to fill gaps in well construction. Wells without a designated aquifer will be reevaluated to further characterize the surrounding geologic units.

Although the spatial density of monitoring meets DWR's recommended guidance, the NCGSA currently plans to construct 4 new dual completion dedicated monitoring wells within the Subbasin to further characterize groundwater conditions. The primary goal of the 4 proposed monitoring sites is to expand the NCGSA's interconnected surface water and groundwater monitoring network, described more in **Section 5.9**. **Figure 5-2** shows the general location of where the 4 new dual completion monitoring sites are planned to be constructed, as well as noting several areas within the Plan area the NCGSA intends to expand groundwater level monitoring. Of the 4 proposed monitoring sites, one site will be located in the NEMA, therefore providing greater vertical discretization of the principal alluvial aquifer. The NCGSA wishes to incorporate GeoTracker regulated wells into the groundwater level monitoring network and plans to contact well owners to propose an agreement for monitoring access. In addition to GeoTracker wells, Napa County has identified several well owners around the Subbasin who have volunteered wells for monitoring. The NCGSA is currently evaluating well information at these volunteered sites to expand the NCGSA groundwater level monitoring network into the several areas identified in **Figure 5-2**.

The NCGSA will apply the following scientific rationale to add new wells into the groundwater level monitoring network:

- Prioritize wells with available construction information
- Prioritize dedicated monitoring wells or unused wells over production wells where feasible
- Prioritize wells that will fill any of the several interest areas noted in **Figure 5-2**

5.5. Groundwater Storage

The objectives of monitoring groundwater storage are to utilize the groundwater level monitoring network within the Subbasin and apply knowledge of aquifer storage coefficients to calculate changes in groundwater storage. These objectives are pursuant of secondary goals that include:

- Improve the understanding of the occurrence and movement of groundwater;
- Monitor local and regional groundwater levels including seasonal and long-term trends in the aquifer system to calculate changes in groundwater storage on an annual basis and in areas where management actions and projects may be planned;

5.5.1. Requirements

In accordance with DWR's Groundwater Monitoring Protocols, Standards, and Sites BMP guidance (DWR, 2016), groundwater levels are employed as a surrogate for monitoring changes in groundwater storage within the Plan area. Detailed in **Section 4**, the Quaternary alluvium is identified as the principal aquifer of the Napa Valley Subbasin and its discrete occurrence within the Plan area is essential to the

NCGSA's assessment of groundwater storage. Changes in groundwater levels reflect changes in storage and can thus be estimated with assumptions of thickness, porosity, and connectivity of the alluvium. Monitoring groundwater storage through groundwater levels requires reliable, consistent, high-quality, defendable data to demonstrate the relationship prior to use as a surrogate for this sustainability indicator.

5.5.2. Monitoring Protocols

5.5.2.1. Methodology

The wells selected for monitoring changes in groundwater storage will be the same for wells used for groundwater level monitoring, therefore, the same protocols applied to the groundwater level monitoring network also apply to the groundwater storage monitoring network.

The NCGSA employs its own methods in calculating change in groundwater storage utilizing groundwater level measurements collected throughout the Subbasin. Groundwater elevation contours for the principal aquifer will be created for each annual report where current year conditions will be compared to the previous groundwater contours generated during the previous year. The change in groundwater elevation at each monitoring site will also be analyzed on a yearly basis to understand where the greatest decline in storage is occurring spatially.

Groundwater storage is a calculated estimate of the total volume of water within the principal aquifer of the Napa Valley Subbasin. To estimate the volume of groundwater in storage, the alluvium's saturated volume is multiplied by an estimated specific yield value of 6% (Kunkel and Upson, 1960). The alluvium's saturated volume is determined by the change in groundwater levels, which when compared to the depth of the base of the alluvium (determined from mapped alluvium isopach contours and geologic cross sections, presented in **Section 4**), a saturated thickness over the whole Subbasin is determined. The calculation of groundwater storage in an unconfined aquifer is represented in the equation below:

$$\text{Change in Aquifer Storage} = (\Delta H) \times (S_y) \times (A)$$

Where:

ΔH = change in hydraulic head (or groundwater elevation)
S_y = Specific Yield of an unconfined aquifer
A = surface area of the basin

5.5.2.2. Frequency

The wells selected for monitoring changes in groundwater storage will be the same wells used for groundwater level monitoring, therefore, the same protocols of monitoring frequency applied to the groundwater monitoring network of the principal aquifer also apply to the groundwater storage monitoring network.

5.5.3. Monitoring Network

Of the groundwater level monitoring network wells, 18 of those wells are designated as screened within the Quaternary alluvium aquifer. The remaining wells are inferred to be screened within the alluvium determined from additional information supplied from well completion reports (WCRs) and surrounding geologic interpretation. Spring seasonal highs in groundwater levels at these sites are used to demonstrate the annual and cumulative change in the volume of groundwater in storage. **Figure 5-3** shows the location of wells in the groundwater storage monitoring network and **Table 5-5** summarizes relevant well information.

Table 5-5: Napa Valley Subbasin Groundwater Storage Monitoring Network Well Information

Well ID	CASGEM ID	Well Type	Latitude	Longitude	Aquifer	Well Depth (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Period of Record	Monitoring Frequency	Monitoring Entity
06N04W17A001M	383721N1223189W001	Domestic	38.3721	-122.3189	Qa	250			1949 - 2019	Monthly	DWR
06N04W27L002M	383359N1222916W001	Domestic	38.3359	-122.2916	Qa	120	60	120	1966 - 2019	Monthly	DWR
07N05W09Q002M	384635N1224182W001	Unused	38.4635	-122.4182	-	232			1949 - 2019	Monthly	DWR
08N06W10Q001M	385529N1225106W001	Unused	38.5529	-122.5106	-	200			1949 - 2019	Monthly	DWR
NapaCounty-127	385926N1225938W001	Domestic	38.593241	-122.592484	-	149			1962 - 2019	Semi-Annual	Napa County
NapaCounty-128	385791N1225636W001	Unused	38.579352	-122.563038	Qa	50			1962 - 2019	Monthly	Napa County
NapaCounty-129	385725N1225709W001	Domestic	38.571574	-122.568316	-	253			1962 - 2019	Semi-Annual	Napa County
NapaCounty-131	384560N1224223W001	Domestic	38.455743	-122.422479	-	221			1963 - 2019	Semi-Annual	Napa County
NapaCounty-132	384616N1223811W001	Irrigation	38.4616	-122.3811	Qa, Tsvab	265	25	265	1962 - 2019	Monthly	Napa County
NapaCounty-133	384116N1223530W001	Domestic	38.411578	-122.352477	Qa	120	20	120	1978 - 2019	Monthly	Napa County
NapaCounty-134	383948N1223497W001	Irrigation	38.3948	-122.3497	Qa	260	160	260	1963 - 2019	Semi-Annual	Napa County
NapaCounty-136	383316N1222987W001	Domestic	38.331302	-122.299419	Qa	120	39	120	1979 - 2019	Monthly	Napa County
NapaCounty-138	384518N1224299W001	Domestic/ Irrigation	38.4518	-122.4299	-	321			1949 - 2019	Semi-Annual	Napa County
NapaCounty-139	383603N1223217W001	Domestic	38.360468	-122.320531	Qa	120	40	120	1978 - 2019	Semi-Annual	Napa County
NapaCounty-152	383358N1223171W001	Domestic	38.335773	-122.317117	-	104			2012 - 2019	Semi-Annual	Napa County
NapaCounty-173		Irrigation	38.498073	-122.475071	-	362			2014 - 2019	Semi-Annual	Napa County
NapaCounty-177		Unused	38.44879	-122.412071	Qa	123	30	122	2014 - 2019	Semi-Annual	Napa County
NapaCounty-179	383779N1223342W001	Domestic	38.37794	-122.334177	-	150	30	150	2014 - 2019	Semi-Annual	Napa County
NapaCounty-183		Domestic/ Irrigation	38.352626	-122.29732	Qa, Tsv?	310			2014 - 2019	Semi-Annual	Napa County
NapaCounty-185		Domestic	38.354875	-122.315387	Qa	260	100	260	2014 - 2019	Monthly	Napa County
NapaCounty-204		Irrigation	38.450245	-122.406113	Qa	220	50	220	2014 - 2019	Semi-Annual	Napa County

NapaCounty-214s-swgw1	383022N1222784W001	Monitoring Well	38.302163	-122.278444	Qa	53	30	50	2014 - 2019	Quarterly	Napa County
NapaCounty-216s-swgw2	383652N1223375W001	Monitoring Well	38.365159	-122.337464	Qa	50	25	45	2014 - 2019	Quarterly	Napa County
NapaCounty-218s-swgw3	383674N1223046W001	Monitoring Well	38.367428	-122.304619	Qa	40	25	35	2014 - 2019	Quarterly	Napa County
NapaCounty-220s-swgw4	384176N1223527W001	Monitoring Well	38.417589	-122.352706	Qa	45	25	40	2014 - 2019	Quarterly	Napa County
NapaCounty-222s-swgw5	385110N1224564W001	Monitoring Well	38.510951	-122.456379	Qa	40	25	35	2014 - 2019	Quarterly	Napa County

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5.5.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitoring groundwater levels within the Plan area include:

- Many existing wells have groundwater level monitoring records of at least 20 years
- A majority of the wells have known construction and aquifer completion information
- Groundwater use in surrounding wells in the area is at a minimum
- Aquifer representation

The overall spatial density of the current groundwater storage monitoring network is approximately 36 wells per 100 square miles. According to guidance presented by DWR (2016b), the current monitoring network satisfies the recommended for monitoring network density of at least 4 wells per 100 square miles. The groundwater storage monitoring network is specific to estimating the quantity of groundwater in storage within the Subbasin's principal alluvial aquifer. Well logs are not available for 4 of the wells included in this network, however, well depth is known, and these wells have been approved by DWR and included in DWR's CASGEM program. Additionally, these wells are located in areas of the Subbasin where the extent of the alluvium is well known.

Groundwater levels are monitored continuously every 4 hours, monthly, and semi-annually to provide seasonal highs and lows in groundwater elevation, satisfying DWR guidance of monitoring at least twice a year. Fourteen of the wells in the groundwater storage monitoring network have records of at least 20 years. Groundwater level measurements have typically been collected within a 3-month window in the fall and spring.

5.5.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

There are currently no data gaps in the groundwater storage monitoring network. The existing network currently collects data at a sufficient quality, frequency, and spatial density to estimate groundwater storage in the principal aquifer. Described in **Section 5.4.5** and **5.4.6**, additional wells planned for the Subbasin will supplement the existing groundwater storage monitoring network.

5.5.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

As stated in the proposed actions to fill data gaps in the groundwater level monitoring network, new wells added to the groundwater level monitoring network will be considered in the groundwater storage monitoring network as well.

In addition to the scientific rationale applied to adding new wells in the groundwater level monitoring network, the following will also apply:

- Well construction information must be available
- Well must be screened within the principal alluvial aquifer

5.6. Seawater Intrusion

Although the Napa Valley Subbasin does not directly border the San Pablo Bay, the Napa-Sonoma Lowlands Subbasin is located adjacent to the bay and delta water ways where seawater naturally occurs. The Napa-Sonoma Lowlands Subbasin lacks groundwater data to sufficiently characterize the source, distribution, and potential movement of salinity in the region, therefore, the NCGSA plans to establish a monitoring network both within and outside the Plan area to proactively address the potential for seawater intrusion into the Napa Valley Subbasin. The objectives of monitoring seawater intrusion in the Subbasin and surrounding areas include the following:

- Proactively establish a monitoring network that can provide basic characterization of groundwater resources in the Napa-Sonoma Lowlands Subbasin to provide an understanding of the pathways by which saltwater may intrude the Napa Valley Subbasin.
- Establish baseline conditions in areas of potential saltwater intrusion, including the extent and natural occurrence and/or causes of saltwater beneath the Carneros, Jameson/American Canyon and Napa River Marshes Subareas.

5.6.1. Requirements

In accordance with GSP Regulations §354.34(c)(3), monitoring for seawater intrusion may be conducted using chloride concentrations or any other measurement that is convertible to chloride concentrations, so that current conditions and the projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated. The dynamics of the seawater-freshwater interface along coastal aquifers is largely controlled by differences in water density and hydraulic head that influence the advancement of seawater into a groundwater basin. Outlined within DWR's Monitoring Networks and Identification of Data Gaps BMP (DWR, 2016), the following practices should be considered to provide data supporting the assessment of seawater intrusion:

- Monitoring groundwater elevations in all seawater intrusion-specific monitoring locations should be consistent with the groundwater level monitoring network and protocols described in DWR BMP guidance.
    - Groundwater quality monitoring from each principal aquifer in the basin that is currently, or may be, impacted by seawater intrusion. Agencies should use to the greatest extent possible existing water quality monitoring data.
    - An adequate spatial density to map an isocontour of chloride (or comparable constituent) advancement front.
    - At least quarterly monitoring that also corresponds with seasonal highs and lows.

- More frequent monitoring may be necessary to assist initial characterization and to evaluate the full dynamic range of aquifer response and associated seawater intrusion.
- Groundwater quality samples should be sufficient to assess groundwater quality impacts on beneficial uses and users

The spatial distribution of monitoring sites for seawater intrusion can be optimized by including geophysical techniques to identify the preferential pathways controlling seawater intrusion. These methods can target critical connections to existing water supply wells and assist in mitigation efforts.

5.6.2. Monitoring Protocols

5.6.2.1. Methodology

The protocols described in **Section 5.6** for groundwater quality monitoring can be applied for seawater intrusion monitoring. Chloride is the most common constituent to monitor seawater intrusion, however, other constituents such as iodide and bromide may also be useful as indicators of the overall groundwater salinity.

5.6.2.2. Frequency

In addition to the protocols described for groundwater quality monitoring, the following additional protocols should be followed regarding the frequency of monitoring:

- Groundwater quality monitoring should be collected and analyzed at least quarterly.
- Groundwater levels should be collected at a frequency adequate to characterize changes in head in the vicinity of the leading edge of degraded water quality in each principal aquifer. Frequency may need to be increased in areas of known preferential pathways, groundwater pumping, or efficacy evaluation of mitigation projects.

5.6.3. Monitoring Network

The seawater/freshwater interface occurs south outside of the Napa Valley Subbasin and its specific location has not yet been determined (see additional discussion in **Section 6**). The spatial distribution of saline groundwater south of the Subbasin is assessed primarily through examination of available chemical indicators, including chloride, total dissolved solids (TDS), electrical conductivity (EC), and sodium concentrations in groundwater. **Figure 5-4** shows the location of wells in the seawater intrusion monitoring network and **Table 5-6** summarizes relevant well information.

Table 5-6: Napa Valley Subbasin Seawater Intrusion Monitoring Network Well Information

Well ID	CASGEM ID	Well Type	Latitude	Longitude	Well Depth (ft bgs)	Period of Record	Measurement Count	Monitoring Entity
05N04W15E001M	382816N1222967W001	Domestic/Irrigation	38.2816	-122.297	158	1958 - 2014	35	DWR
04N04W05C001M	382285N1223290W001	Unknown GW Supply	38.22848	-122.329		1958 - 2008	33	DWR
05N04W21P002M		Unknown GW Supply	38.2601	-122.311		1952 - 2014	32	DWR
04N04W05D002M	382276N1223310W001	Domestic	38.2276	-122.331	60	1951 - 2014	26	DWR
05N04W29H001M	382527N1223201W001	Domestic	38.2527	-122.32	44	1951 - 2002	21	DWR
04N04W04C002M		Unknown GW Supply	38.22885	-122.31		1972 - 2013	12	DWR
381153122185701		Unknown GW Supply	38.19813889	-122.315861	306	2004 - 2014	9	USGS
381440122191101		Unknown GW Supply	38.24452778	-122.3198056	200	2004 - 2014	5	USGS

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The highest historically observed concentrations of each of these constituents are observed in three areas south of the Subbasin, in the Napa River Marshes, Jameson/American Canyon, and Carneros areas. Groundwater quality and well construction data from these areas are very limited and, therefore, restrict the spatial-temporal resolution of groundwater salinity and the location of the seawater/freshwater interface. Nonetheless, the NCGSA monitors one well in the southern vicinity of the Napa Valley Subbasin specific for the purposes of monitoring for seawater intrusion. This monitoring site was chosen due to its moderate record, in which monitoring began in 1978.

5.6.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitor seawater intrusion include:

- A majority of the existing wells have groundwater quality records of at least 40 years
- The location of wells in key areas to monitor the potential progression of the seawater/freshwater interface
- Groundwater use in surrounding wells in the area is at a minimum

A total of 8 seawater intrusion monitoring sites are included in the Subbasin's monitoring network, with 7 of the sites located outside of the Subbasin boundary. The area between the Subbasin and the San Pablo Bay is approximately 25 square miles, resulting in a spatial density of roughly 32 wells per 100 square miles.

Groundwater quality and well construction data for this area are very limited and, therefore, restrict the spatial-temporal resolution of groundwater salinity and the location of the seawater/freshwater interface. Well log information is not available for the wells in this network and only several wells have a known well depth. The most recent measurements collected from the seawater intrusion monitoring network occurred in 2014. While a majority of the wells in the network have records of at least 20 years, there has been no consistent frequency of monitoring.

5.6.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

The NCGSA has identified data gaps in the seawater intrusion monitoring network for the Napa Valley Subbasin and has summarized the information in **Table 5-7**.

Table 5-7: Data Gaps in the Seawater Intrusion Monitoring Network

Data Gap Type	Applicable Wells
Insufficient well construction information	04N04W05C001M 05N04W21P002M 04N04W05D002M

Insufficient monitoring frequency	Overall Network

5.6.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

In accordance with GSP Regulations §352.4(2), the NCGSA will retrieve the necessary construction information for the groundwater level monitoring wells currently lacking this information. If construction data are not documented, the well depth will be determined using a sounder equipment and a downhole well survey may be utilized to fill additional gaps in well construction information.

Although the approximate spatial density of the seawater intrusion monitoring network is sufficient according to DWR guidance, the NCGSA wishes to increase coverage of monitoring in the southern portion of the Subbasin and in the Napa-Sonoma Lowlands. Described in **Section 5.4.6**, the NCGSA currently plans to construct 4 new dual completion dedicated monitoring wells within the Subbasin to further characterize groundwater conditions. Of these wells, one site, consisting of two monitoring wells, will be added to the seawater intrusion monitoring network. Additionally, the NCGSA wishes to expand spatial coverage south of the Subbasin and plans to reach out to regulated GeoTracker facilities and volunteer wells to secure reliable monitoring sites.

The NCGSA will apply the following scientific rationale to add new wells into the seawater intrusion monitoring network:

- Prioritize wells with available construction information
- Prioritize dedicated monitoring wells or unused wells over production wells where feasible
- Prioritize wells with past groundwater quality data

The NCGSA plans to address temporal data gaps in the seawater monitoring network by first reevaluating the accessibility and site conditions of each monitoring well. As the wells in the network have not been monitored in the last several years, the NCGSA must determine if the wells are viable to continue future monitoring. After wells are confirmed reliable monitoring sites, semi-annual monitoring of groundwater quality will be implemented, in which samples will be analyzed for dissolved chloride and TDS at a minimum.

5.7. Water Quality

5.7.1. Groundwater Quality

The sustainability indicator for degraded water quality is evaluated by monitoring groundwater quality at a network of existing supply wells. The objectives of the groundwater quality monitoring network for the Subbasin include the following:

- Evaluate groundwater quality conditions in various areas of the Subbasin, and identify differences in water quality spatially between areas and vertically in the aquifer system;
- Detect the occurrence of and factors attributable to natural (e.g., general minerals and trace metals) constituents of concern as represented by TDS;
- Assess the changes and trends in groundwater quality (seasonal, short- and long-term trends);
- Identify the natural and human factors that affect changes in water quality.

5.7.1.1. Requirements

In accordance with GSP Regulations §354.34(c)(4), monitoring of groundwater quality must collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues. Following BMPs outlined in DWR's Monitoring Networks and Identification of Data Gaps BMP guidance, the groundwater quality monitoring network should be sufficient to demonstrate that the degraded water quality sustainability indicator is being observed for the purpose of meeting the sustainability goal. Monitoring is recommended in locations where known groundwater contamination plumes exist and are under an existing regulatory management and monitoring program. Although the NCGSA is not required to monitor existing contamination sites, the NCGSA is required to consider the impacts of any projects and management actions that would influence contaminant migration. Seawater intrusion and degraded groundwater quality are interrelated, and the requirements laid out for groundwater quality monitoring can be applied to monitoring of seawater intrusion. In addition to requirements laid out in the GSP Regulations, DWR BMPs recommend the following be employed by GSPs in monitoring of groundwater quality in basins that are currently, or may be in the future, impacted by degraded water quality:

- Adequate spatial distribution to map or supplement mapping of known contaminants in the principal aquifers of the basin, and sufficient data to map the movement of degraded water quality.
- Define the three-dimensional extent of any existing degraded groundwater quality impact.
- That data should be sufficient to assess groundwater quality impacts to the beneficial uses and users of groundwater and evaluate whether management activities are contributing to water quality degradation.

5.7.1.2. Monitoring Protocols

Methodology

According to the protocols for groundwater quality sampling outlined in Monitoring Protocols, Standards, and Sites BMPs by DWR (2016), any GSPs that adopt protocols outside of what is recommended in DWR's BMPs must demonstrate that the adopted protocols yield comparable data. The use of existing water quality data within the basin is encouraged to the greatest extent possible, however, where necessary, additional groundwater quality data are needed to support monitoring programs or specific projects. The USGS National Field Manual for the Collection of Water Quality Data

(Wilde, 2005) is recommended by DWR to guide the collection of reliable data. Additionally, DWR recommends all water quality analyses be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program.

Groundwater sampling protocols should ensure data is collected from the correct location, is accurate and reproducible, and representative of conditions that inform appropriate basin management. Standardized protocols for groundwater quality collections include some of the following:

- Prior to sampling, the analytical laboratory will be contacted to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring will have a unique identifier. This identifier will appear on the well housing or the well casing to verify well identification.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead following purging. **Appendix 5C** outlines sample collection procedures for wells equipped with a pump.
- Prior to sampling, the sampling port and sampling equipment will be cleaned of any contaminants.
- The equipment will be decontaminated between each sampling locations or wells to avoid cross contamination.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling.
- Field parameters of pH, electrical conductivity and temperature should be collected during purging and prior to the collection of each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH should only be measured in the field; lab pH analysis are typically unachievable due to short hold times. Other parameters, such as Oxidation-Reduction Potential (ORP), Dissolved Oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for assessing purge conditions. All field instruments will be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location preservative used, and analytes and analytical method.

- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Ensure the laboratory uses appropriate reporting limits that are at or below levels needed for the objectives of the monitoring.
- Groundwater quality samples are to be collected annually for key constituents and every five years for all other constituents.
- For wells monitored by other entities, obtain results and associated information on sampling activities through coordination and communication directly with the monitoring entity or through public databases.

All groundwater quality data and other information from sampling activities should be entered into the DMS as soon as possible and in accordance with established QA/QC procedures. Care should be taken during any data entry to avoid mistakes and data entered into the database should be checked for accuracy and completeness.

Frequency

DWR BMP guidance leaves the frequency of groundwater quality monitoring subject to professional opinion, however, recommends monitoring should occur in parallel to the seasonal highs and lows. Monitoring frequency may be more frequent where appropriate.

5.7.1.3. Monitoring Network

There are 12 groundwater quality monitoring sites within the NCGSA, accounting for 17 individual wells. These wells are monitored monthly by DWR and quarterly by Napa County. Wells monitored by the USGS have no consistent monitoring frequency currently. **Figure 5-5** shows the location of wells in the groundwater quality monitoring network and **Table 5-8** summarizes relevant well information.

Table 5-8: Napa Valley Subbasin Groundwater Quality Monitoring Network Well Information

Well ID	CASGEM ID	Well Type	Latitude	Longitude	Aquifer	Well Depth (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Period of Record	Monitoring Frequency	Monitoring Entity
06N04W17A001M	383721N1223189W001	Domestic	38.3721	-122.3189	Qa	250			1949 - 2019	Monthly	DWR
06N04W27L002M	383359N1222916W001	Domestic	38.3359	-122.2916	Qa	120	60	120	1966 - 2019	Monthly	DWR
NapaCounty-214s-swgw1	383022N1222784W001	Monitoring Well	38.302163	-122.278444	Qa	53	30	50	2014 - 2019	Variable	Napa County
NapaCounty-215d-swgw1	383022N1222784W002	Monitoring Well	38.302163	-122.278444	Qa	98	75	95	2014 - 2019	Variable	Napa County
NapaCounty-216s-swgw2	383652N1223375W001	Monitoring Well	38.365159	-122.337464	Qa	50	25	45	2014 - 2019	Variable	Napa County
NapaCounty-217d-swgw2	383652N1223375W002	Monitoring Well	38.365159	-122.337464	Qa	86	71	81	2014 - 2019	Variable	Napa County
NapaCounty-218s-swgw3	383674N1223046W001	Monitoring Well	38.367428	-122.304619	Qa	40	25	35	2014 - 2019	Variable	Napa County
NapaCounty-219d-swgw3	383674N1223046W002	Monitoring Well	38.367428	-122.304619	Qa	93	78	88	2014 - 2019	Variable	Napa County
NapaCounty-220s-swgw4	384176N1223527W001	Monitoring Well	38.417589	-122.352706	Qa	45	25	40	2014 - 2019	Variable	Napa County
NapaCounty-221d-swgw4	384176N1223527W002	Monitoring Well	38.417589	-122.352706	Qa	85	70	80	2014 - 2019	Variable	Napa County
NapaCounty-222s-swgw5	385110N1224564W001	Monitoring Well	38.510951	-122.456379	Qa	40	25	35	2014 - 2019	Variable	Napa County
NapaCounty-223d-swgw5	385110N1224564W002	Monitoring Well	38.510951	-122.456379	Qa	100	80	95	2014 - 2019	Variable	Napa County
381639122150801		Unknown GW Supply	38.27775	-122.2522222		417			2004 - 2019	Variable	USGS
381932122172601		Unknown GW Supply	38.3256111	-122.2906389		235			2004 - 2019	Variable	USGS
382553122232501		Unknown GW Supply	38.4314722	-122.3902778		400			2004 - 2019	Variable	USGS
383038122271301		Unknown GW Supply	38.51069444	-122.4537222		670			2004 - 2019	Variable	USGS
383148122292901		Unknown GW Supply	38.53019444	-122.4915556		460			2004 - 2019	Variable	USGS

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5.7.1.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitoring groundwater quality within the Plan area include:

- A majority of the wells are dedicated monitoring sites
- Dedicated monitoring sites are dual completion wells, offering greater aquifer representation
- Domestic wells included in the network have monitoring records of at least 20 years
- A majority of the wells have known construction and aquifer completion information
- Groundwater use in surrounding wells in the area is at a minimum

The overall spatial density of the current groundwater quality monitoring network is approximately 24 wells per 100 square miles. According to DWR BMPs (DWR, 2016b), the current monitoring network satisfies the minimum well density recommended by DWR of 4 wells per 100 square miles for monitoring networks.

Well construction information is available for all but 5 wells monitored by the USGS, although well depth is known for these wells. Wells with construction information are designated within the principal alluvial aquifer, in which the 10 dedicated monitoring wells are each screened within a shallow and deep zone. There are currently no groundwater quality monitoring wells designated within the secondary volcanic aquifer.

Groundwater quality is monitored monthly at 2 wells by DWR. The remainder of the wells in the existing network do not have a consistent monitoring frequency currently.

5.7.1.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

The NCGSA has identified data gaps in the groundwater quality monitoring network for the Napa Valley Subbasin and has summarized the information in **Table 5-9**.

Table 5-9: Data Gaps in the Groundwater Quality Monitoring Network

Data Gap Type	Applicable Wells
Insufficient well completion information	381639122150801 381932122172601 382553122232501 383038122271301 383148122292901
Insufficient spatial coverage	
Insufficient monitoring frequency	NapaCounty-214s-swgw1 NapaCounty-215d-swgw1 NapaCounty-216s-swgw2

	NapaCounty-217d-swgw2 NapaCounty-218s-swgw3 NapaCounty-219d-swgw3 NapaCounty-220s-swgw4 NapaCounty-221d-swgw4 NapaCounty-222s-swgw5 NapaCounty-223d-swgw5 381639122150801 381932122172601 382553122232501 383038122271301 383148122292901

5.7.1.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

In accordance with GSP Regulations §352.4(2), the NCGSA will retrieve the necessary construction information for the groundwater quality monitoring wells identified in **Table 5-9** currently lacking this information. If construction data are not documented, the well depth will be determined using a sounder equipment and a downhole well survey may be utilized to fill additional gaps in well construction information.

Described in **Section 5.4.6**, the NCGSA has identified several volunteer wells and plans to identify GeoTracker regulated wells to potentially add to the groundwater level monitoring network. Wells considered for the groundwater level monitoring network will also be evaluated for the groundwater quality monitoring network.

The NCGSA will apply the following scientific rationale to add new wells into the groundwater quality monitoring network:

- Prioritize wells with available construction information
- Prioritize dedicated monitoring wells or unused wells over production wells where feasible
- Prioritize wells with a significant period of record of groundwater quality data
- Prioritize wells screened within the secondary volcanic aquifer
- Groundwater utilization of the wells and the surrounding areas are at a minimum

The NCGSA plans to address temporal data gaps in the groundwater quality monitoring network by implementing annual monitoring of groundwater quality. In accordance with DWR guidance, water quality samples will be collected and analyzed at least once a year, in which samples will be analyzed for dissolved chloride at a minimum.

5.7.2. Surface Water Quality

Where surface water is interconnected with groundwater, the quality of water being exchanged between the two sources can have an impact on the receiving body. Although the SWRCB assumes the regulatory responsibilities of monitoring and managing surface waters for the state, the NCGSA conducts to a small degree its own surface water quality monitoring within the Plan area in juxtaposition with the monitoring network for interconnected surface water and groundwater. Surface water quality monitoring at select sites within the Plan area assists in characterizing the degree of surface water-groundwater connection within the Subbasin.

In arrangement with existing surface water quality monitoring sites and sites managed by the NCGSA, the objectives of the surface water quality monitoring network include:

- Identify and characterize the geological, hydrological, and chemical factors that influence the transition zone between surface water and groundwater
- Determine the relationship between surface water quality and groundwater quality at the dedicated surface water-groundwater monitoring sites in the Subbasin

5.7.2.1. Requirements

Surface water quality monitoring is not a requirement under GSP Regulations.

5.7.2.2. Monitoring Protocols

Methodology

Surface water quality monitoring can be conducted using both instantaneous field sampling and continuous water quality monitoring sensors. The USGS provides guidelines and standard procedures in both their *Field Guide for Collecting and Processing Stream-Water Samples for the National Water Quality Assessment Program* (1994) and *Guidelines and Standard Procedures for Continuous Water Quality Monitors: Station Operation, Record Computation, and Data Reporting* (2006) (Shelton, 1994 and Wagner and Others, 2006).

Frequency

The frequency at which surface water quality sampling should occur is at the discretion of professional judgement. Generally, monitoring frequency at sites where water quality varies considerably should be higher than at sites where water quality remains relatively constant.

5.7.2.3. Monitoring Network

A supplementary component of the Napa Valley Subbasin's monitoring network for interconnected surface water and groundwater includes 5 stream transducers managed by Napa County. Deployed in 2015, the transducers are programmed to collect stream stage and water quality data (temperature, specific conductance) at 4-hour intervals. These transducers are located adjacent to the 5 dedicated monitoring sites for interconnected surface water and groundwater described in **Section 5.9**. In addition

to the sites monitored by Napa County, two sites are monitored by the USGS at a variable frequency. Water quality data collected at the USGS include an array of constituents incorporated in physical, inorganic, organic, biological, and nutrient testing. **Figure 5-6** shows the surface water quality monitoring network and **Table 5-10** summarizes relevant site information.

Table 5-10: Napa Valley Subbasin Surface Water Quality Monitoring Network Site Information

Site ID	Site Type	Latitude	Longitude	Monitored Water Quality Constituents	Period of Record	Monitoring Frequency	Measurement Count	Monitoring Entity
NapaCounty-swgw-1	River	38.302347	-122.278728	T, SC, Salinity, TDS	2015 - 2020	4 hours	-	Napa County
NapaCounty-swgw-2	River	38.365099	-122.338073	T, SC, Salinity, TDS	2015 – 2019	4 hours	-	Napa County
NapaCounty-swgw-3	River	38.367979	-122.303556	T, SC, Salinity, TDS	2015 – 2020	4 hours	-	Napa County
NapaCounty-swgw-4	River	38.418316	-122.351872	T, SC	2015 – 2016	4 hours	-	Napa County
NapaCounty-swgw-5	River	38.5111752	-122.4549746	T, SC, Salinity, TDS	2015 - 2020	4 hours	-	Napa County
11458300	Stream	38.30185880	-122.30386340	Various*	1976 - 2018	Variable	36	USGS
382017122161101	Stream	38.33805556	-122.26972220	Various*	2001 - 2018	Variable	31	USGS

Note:
T = Temperature
SC = Specific Conductivity
TDS = Total Dissolved Solids
*Various water quality constituents are included in USGS monitoring, which conduct physical, inorganic, organic, biological, and nutrient testing.

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5.7.2.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitoring surface water quality within the Plan area include:

- Prioritize sites in the vicinity to wells in the interconnected surface water and groundwater monitoring network
- Prioritize sites located on major rivers and streams within the Subbasin

Monitoring of surface water quality is not a requirement under GSP Regulations, however, the framework of a surface water quality monitoring network is dependent upon the monitoring objectives and ability to sufficiently characterize the hydrologic conditions of interest. The main objectives of the surface water quality monitoring network support monitoring conducted at the interconnected surface water and groundwater monitoring sites (**Section 5.9**), therefore, the adequacy of this network is determined by its spatial and temporal coverage coincident with this other network. The surface water quality monitoring sites collected by Napa County coincide with the locations of the dedicated monitoring sites within the interconnected surface water and groundwater monitoring network, in which both sites collect groundwater levels and surface water quality data at a frequency of every 4 hours.

5.7.2.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

There are currently no data gaps in the surface water quality monitoring network. The existing network currently fulfills its role in collecting surface water quality data at the coincident dedicated monitoring sites within the interconnected surface water and groundwater monitoring network and at the same frequency.

5.7.2.6. Proposed Actions to Address Data Gaps

Described in **Section 5.4** and **Section 5.9**, the NCGSA plans to construct 4 new dual completion monitoring sites throughout the Subbasin. These sites are in the vicinity of the Napa River or a tributary stream, in which the NCGSA plans to expand surface water quality monitoring at these new sites.

The NCGSA will apply the following scientific rationale when considering new surface water quality monitoring sites to the network, in response to new monitoring wells added to any of the monitoring networks within the Plan area:

- Prioritize dedicated monitoring sites within the interconnected surface water and groundwater monitoring network that do not currently have a coincident surface water quality monitoring site

- Prioritize groundwater level monitoring sites located along major rivers and streams within the Subbasin where a potential connection between surface water and groundwater may be present.

5.8. Land Subsidence Monitoring Network

The objectives of the land subsidence monitoring network for the Subbasin include the following:

- Efficiently collect, store, and report the conditions of land subsidence within the Subbasin using the available monitoring sites and data sources at hand
- Identify areas where subsidence conditions may potentially exist in the future

5.8.1. Requirements

In accordance with GSP Regulations §354.34(c)(5), the land subsidence monitoring network must be sufficient to identify the rate and extent of land subsidence within the Plan area. Land subsidence may be measured using several techniques, including extensometers, surveying, remote sensing technology, or other appropriate techniques. The land subsidence monitoring network should use existing data to the greatest extent possible and provide consistent, accurate, and reproducible results. In addition to the various techniques that measure land surface elevation, groundwater levels may be used as a surrogate to correlate with conditions of land subsidence. The land subsidence monitoring network should consider the following:

- Potential for subsidence to occur, supported by the Plan area's hydrogeologic conceptual model (HCM), geologic conditions and historical groundwater levels
- Existing continuous global position system (CGPS) surveys and remote sensing results

The land subsidence monitoring network may employ multiple methods of measuring land surface elevation. Whichever techniques are used by the network must adhere to the various standards and guidance documents, including but not limited to, levelling survey standards, CGPS survey standards, borehole extensometer standards, and Interferometric Synthetic Aperture Radar (InSAR) data and processing standards.

5.8.2. Monitoring Protocols

5.8.2.1. Methodology

There is currently no standardized protocol for collection of land surface elevation data specific to monitoring for land subsidence, however, various methods exist that are sufficient in evaluating and monitoring inelastic land subsidence. To collect land surface elevation data where land subsidence exists or is suspected to exist in the future, DWR outlined the following recommendations in the Groundwater Monitoring Protocols, Standards, and Sites BMP report (DWR, 2016):

- Proper characterization of land subsidence conditions using existing long-term leveling surveys of regional infrastructure

- Monitoring in regions of suspected subsidence where potential exists, using CGPS networks, leveling surveys, extensometer networks, and/or remote sensing methods

Any of the methods described above to monitor land surface elevation must adhere to the standards and guidance documents for each technique. Leveling and GPS surveys must follow standards set forth in the California Department of Transportation's Caltrans Surveys Manual, borehole extensometers must follow the manufacturer's instructions for installation, care, and calibration, and remote sensing techniques must follow the recommended methods of data processing.

Additional protocols for subsidence monitoring in the Subbasin will include the following:

- Download and review subsidence data collected by the NGS at the operational survey benchmarks, InSAR data provided by DWR, and all other data sources that may become relevant to the Plan area
- Downloaded data will be stored in the DMS following QA/QC

5.8.2.2. Frequency

GSP Regulations and BMP guidance do not provide explicit monitoring frequency of a land subsidence monitoring network, however, GSP Regulations §354.16(e) require the data be sufficient enough to provide maps that represent the extent, cumulative total, and annual rate of land subsidence within the Plan area. Where data are collected from monitoring sites at a frequency greater than one year, the annual rate of land subsidence can be calculated so long as at least two data points exist for a site. InSAR data, provided by DWR to GSAs for the purpose of incorporating into GSPs, is collected periodically by the European Space Agency (ESA) Sentinel-1A satellite.

5.8.3. Monitoring Network

Land subsidence within the Plan area is minimal, as land benchmarks have shown sub-foot changes (both downwards and upwards) of land surface elevation in over two decades. Land subsidence is monitored within the Plan area using the following two methods and technology:

1) Leveling survey data from the NGS
2) Remote InSAR data from radar emitting satellites

National Geodetic Survey (NGS). For the United States, the NGS (formerly known as the U.S. Coast and Geodetic Survey), is the most complete source for digital National Spatial Reference System (NSRS) data. The NGS is responsible for defining, managing, and providing public access to the NSRS, which provides a consistent national coordinate system for mapping latitude, longitude, and elevation with high accuracy. There are 8 NGS benchmark stations within the Plan area that are spaced across the length of the Napa Valley Floor. Survey benchmark sites monitored by the NGS possess historical elevation measurements from the early 1990s with most recent measurements in 2020. NGS benchmarks report a confidence interval of 95% for surveyed land surface elevations, in which it may be important to note that measurements taken before 2000 may have greater noise and historical error.

Interferometric Synthetic Aperture Radar (InSAR). InSAR is an invaluable satellite-based remote-sensing technique that uses radar signals to measure land surface deformation at an unprecedented level of spatial detail and high degree of measurement resolution. DWR obtains satellite derived InSAR data from the ESA that is processed by TRE ALTAMIRA Inc. to provide estimates of vertical land displacement. Statewide InSAR data coverage is available from January 2015 to September 2019, which provides point data that represent vertical displacement at a resolution of 100-meter by 100-meter areas. Additionally, DWR provide GIS rasters of the interpolated point data representing total vertical displacement relative to June 2015 and annual vertical displacement rates, both in monthly time steps. InSAR data provides regional mapping for the majority of the Plan area (with the exception of small gaps) and has a relative accuracy within fractions of an inch. InSAR data provided by DWR will be updated periodically.

Figure 5-7 shows the location of NGS land survey elevation benchmarks in the land subsidence monitoring network and the spatial coverage of InSAR data available within the Plan area. An attribute table of relevant NGS survey benchmark information is shown in **Table 5-11**.

Table 5-11: Napa Valley Subbasin Land Surface Elevation Monitoring Site Information

NGS Elevation Benchmark Site ID	USGS Quad	Latitude	Longitude	Survey Dates	Elevation (ft)
JT9631	Calistoga	38.56444444	-122.55361111	8/11/1994	316.9
				2/10/2007	316.5
				6/27/2012	316.6 ± 0.2
DR5646	Calistoga	38.53769444	-122.50750000	8/6/2020	312.9
DR5677	Rutherford	38.48277778	-122.44250000	8/6/2020	198.7
JT9565	Rutherford	38.44111111	-122.40666667	5/15/1992	151.0039
				4/6/2000	150.6561
				2/10/2007	150.5249
				6/27/2012	150.5905 ± 0.0547
DR5674	Yountville	38.39682778	-122.35972222	8/6/2020	94.3
JT0442	Napa	38.34729444	-122.32861111	??/??/1992	100.784121
				8/6/2020	103.3
DR5673	Napa	38.32096389	-122.30916667	8/6/2020	74.8
JT9621	Napa	38.27111111	-122.29944444	8/11/1994	10.4166
				2/10/2007	9.7736
				6/27/2012	9.8425 ± 0.2814

5.8.4. Monitoring Network Assessment

The overall spatial density of the current land subsidence monitoring network is approximately 11 monitoring benchmarks per 100 square miles. DWR BMPs (DWR, 2016b) do not specify a prescriptive land subsidence monitoring network density, however, the NCGSA's land subsidence monitoring network provides sufficient spatial density across the length of the Napa Valley Subbasin to indicate changes in land surface elevation.

The NGS benchmark stations have been measured approximately every several years at no consistent frequency. Although land surface elevation data provided by InSAR data improves the temporal data gaps derived from the NGS benchmark stations, the NCGSA does not consider it a replacement for land-based measurements.

5.8.5. Data Gaps

The NCGSA has identified data gaps in the land subsidence monitoring network for the Napa Valley Subbasin and has summarized the information in **Table 5-12**. Land subsidence is commonly evaluated on

an annual schedule, therefore, monitoring of the land subsidence survey benchmarks should occur at least once a year.

Table 5-12: Data Gaps in the Land Subsidence Monitoring Network

Data Gap Type	Applicable Sites
Insufficient monitoring frequency	Land-based Monitoring sites

5.8.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

To implement a consistent monitoring frequency for the NGS elevation benchmarks, the NCGSA will hire an outside firm experienced in leveling and GPS surveying to conduct yearly surveys of the benchmarks throughout the Subbasin. The NCGSA will assure surveys are conducted using consistent methods and according to the standards set forth in the California Department of Transportation's Caltrans Surveys Manual.

5.9. Interconnected Surface Water and Groundwater Monitoring Network

Along with supplemental surface water quality monitoring data, the objectives of the interconnected surface water and groundwater monitoring network include:

- Characterizing the spatial and temporal exchanges between surface water and groundwater
- Apply data to modeling techniques to facilitate the calculation and quantification of surface water-groundwater exchange

The NCGSA acknowledges the significance of interconnected surface water and groundwater in the Subbasin to groundwater users, surface water users, riparian rights holders, GDEs, and other stakeholders. Groundwater levels in the proximity of significant rivers and streams will continue to be monitored within the Plan area to better characterize the hydrologic conditions and impacts seen to beneficial users.

5.9.1. Requirements

In accordance with GSP Regulations §354.34(c))(6), monitoring of interconnected surface water and groundwater must be sufficient to characterize the spatial and temporal exchanges between surface water and groundwater and calculate the depletions of surface water by groundwater extractions, using existing stream gaging and groundwater level monitoring networks to the extent possible. The California Code of Regulations (CCR) Title 23, Division 2, Chapter 1.5 has defined interconnected surface water as surface water that is hydraulically connected at any point in time by a continuous zone of saturated

media to the underlying aquifer and the overlying surface water is not completely depleted. The monitoring network for interconnected surface water and groundwater must characterize the following:

- Flow conditions, surface water discharge, surface water head, and baseflow contribution
- Approximate date and location where ephemeral or intermittent streams and rivers cease to flow, where applicable
- Temporal changes in conditions due to variations in stream discharge and regional groundwater extraction
- Other factors necessary to identify adverse impacts on the beneficial uses of surface water

Monitoring of interconnected surface water and groundwater commonly requires some form of modeling to estimate the depletions associated with groundwater extraction. According to DWR's Monitoring Networks and Identification of Data Gaps BMP guidance, assumptions made during any modeling approach should be based on empirical observations determining the extent of connection between surface water and groundwater, the timing of observed connections, the flow dynamics of both surface water and groundwater systems, and the hydrogeologic properties of the monitoring sites. DWR BMPs for establishing a surface water-groundwater monitoring network provide additional components to consider, including:

- Establish stream gaging along sections of known surface water-groundwater connection
- Establish shallow groundwater monitoring to characterize groundwater levels adjacent to connected streams

Other methods of site characterization recommended by DWR include the use of streambed conductance surveys, aquifer testing, isotopic or geochemical studies, and geophysical studies.

5.9.2. Monitoring Protocols

5.9.2.1. Methodology

Data collected from the groundwater level monitoring network are employed to monitor interconnected surface water and groundwater, therefore, the same protocols applied to the groundwater level monitoring network also apply to groundwater level monitoring sites incorporated into this monitoring network.

In addition to monitoring groundwater levels, streamflow monitoring is necessary for incorporation into a water budget analysis and use in the evaluation of stream depletions associated with groundwater extractions. According to DWR's Groundwater Monitoring Protocols, Standards, and Sites BMP guidance, the use of existing monitoring locations should be incorporated into the monitoring network to the greatest extent possible. DWR refers to procedures outlined in USGS Water Supply Paper 2175, Volume 1. – Measurement of Stage Discharge and Volume 2. – Computation of Discharge for methods to collect, analyze, and report streamflow measurements (Rantz and others, 1982a).

If establishing new streamflow sites, the following should be considered:

- Once a site is selected, a relationship between stream discharge and stream stage is necessary to provide continuous estimates of streamflow
- To develop ratings curves correlating stage and discharge, several measurements of discharge at different stream stages is necessary, where professional judgment must be exercised to determine the appropriate methodology
- Following development of the ratings curve a simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis

5.9.2.2. Frequency

Data collected from the groundwater level monitoring network are employed to monitor interconnected surface water and groundwater, therefore, the same protocols applied to the groundwater level monitoring network also apply to this monitoring network.

5.9.3. Monitoring Network

Of the 56 groundwater level monitoring sites within the Plan area, 5 sites are dedicated dual-completion monitoring sites enabled exclusively to monitor groundwater conditions at specific depths. In addition to 5 dedicated surface water-groundwater monitoring sites, which accounts for 10 monitoring wells total, 6 wells from the groundwater level monitoring network are included to monitor interconnected surface water and groundwater. **Figure 5-8** shows the location of wells in the interconnected surface water and groundwater monitoring network and **Table 5-13** summarizes relevant well information.

Table 5-13: Napa Valley Subbasin Interconnected Surface Water and Groundwater Monitoring Site Information

Well ID	CASGEM ID	Well Type	Latitude	Longitude	Aquifer	Well Depth (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Period of Record	Monitoring Frequency	Monitoring Entity
NapaCounty-214s-swgw1	383022N1222784W001	Monitoring Well	38.302163	-122.278444	Qa	53	30	50	2014 - 2019	4 hours	Napa County
NapaCounty-215d-swgw1	383022N1222784W002	Monitoring Well	38.302163	-122.278444	Qa	98	75	95	2014 - 2019	4 hours	Napa County
NapaCounty-216s-swgw2	383652N1223375W001	Monitoring Well	38.365159	-122.337464	Qa	50	25	45	2014 - 2019	4 hours	Napa County
NapaCounty-217d-swgw2	383652N1223375W002	Monitoring Well	38.365159	-122.337464	Qa	86	71	81	2014 - 2019	4 hours	Napa County
NapaCounty-218s-swgw3	383674N1223046W001	Monitoring Well	38.367428	-122.304619	Qa	40	25	35	2014 - 2019	4 hours	Napa County
NapaCounty-219d-swgw3	383674N1223046W002	Monitoring Well	38.367428	-122.304619	Qa	93	78	88	2014 - 2019	4 hours	Napa County
NapaCounty-220s-swgw4	384176N1223527W001	Monitoring Well	38.417589	-122.352706	Qa	45	25	40	2014 - 2019	4 hours	Napa County
NapaCounty-221d-swgw4	384176N1223527W002	Monitoring Well	38.417589	-122.352706	Qa	85	70	80	2014 - 2019	4 hours	Napa County
NapaCounty-222s-swgw5	385110N1224564W001	Monitoring Well	38.510951	-122.456379	Qa	40	25	35	2014 - 2019	4 hours	Napa County
NapaCounty-223d-swgw5	385110N1224564W002	Monitoring Well	38.510951	-122.456379	Qa	100	80	95	2014 - 2019	4 hours	Napa County
06N04W17A001M	383721N1223189W001	Domestic	38.3721	-122.3189	Qa	250			1949 - 2019	Monthly	DWR
07N05W09Q002M	384635N1224182W001	Unused	38.4635	-122.4182	Not Determined	232			1949 - 2019	Monthly	DWR
08N06W10Q001M	385529N1225106W001	Unused	38.5529	-122.5106	Not Determined	200			1949 - 2019	Monthly	DWR
06N04W27L002M	383359N1222916W001	Domestic	38.3359	-122.2916	Qa	120	60	120	1966 - 2019	Monthly	DWR
NapaCounty-128	385791N1225636W001	Unused	38.579352	-122.563038	Qa	50			1962 - 2019	Monthly	Napa County
NapaCounty-133	384116N1223530W001	Domestic	38.411578	-122.352477	Qa	120	20	120	1978 - 2019	Monthly	Napa County

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Constructed in 2014, the dual-completion wells consist of two separate casings in a single borehole. Each casing is independent of the other with distinct total depths and screen intervals. The construction details for each casing were developed based on site-specific hydrogeologic and surface water channel considerations. Four of the dedicated surface water-groundwater monitoring wells are located along the Napa River and one is located along Dry Creek.

In general, groundwater monitoring facilities at each site consist of one shallow casing constructed to represent groundwater conditions at the water table surface and at elevations similar to the adjacent surface water channel. The second casing at each site is constructed to a deeper depth with screen intervals coinciding with aquifer materials and depths likely to be accessed by production wells in the vicinity. Paired casings are separated within the borehole by intermediate seals designed to provide a physical separation such that groundwater conditions reflected by each casing are not influenced by conditions in other portions of the groundwater system.

5.9.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitoring interconnected surface water and groundwater within the Plan area include:

- A majority of the wells are dedicated monitoring sites
- Dedicated monitoring sites are dual completion wells, offering greater aquifer representation
- Non-dedicated monitoring wells included in the network have monitoring records of at least 40 years and are in the vicinity of a stream
- A majority of the wells have known construction and aquifer completion information
- Groundwater use in surrounding wells in the area is at a minimum

The overall spatial density of the current interconnected surface water and groundwater monitoring network is approximately 22 wells per 100 square miles. Although the current monitoring network is sufficient according to DWR standards, the NCGSA recognizes the variability in geologic conditions that affect interconnected surface water and groundwater and acknowledges the need to expand the monitoring network to better characterize these conditions within the Subbasin. Additionally, groundwater pumping is not evenly distributed throughout the Subbasin, therefore, there is a need to monitor areas of increased groundwater extractions to quantify potential depletions of surface water.

Groundwater levels are monitored monthly at DWR sites and every 4 hours at Napa County sites, satisfying DWR guidance of monitoring groundwater levels at least twice a year. Monthly monitoring by DWR is also considered adequate to the NCGSA, resulting in a sufficient monitoring frequency for the NCGSA to determine seasonal highs and lows in the network.

Data collected from the interconnected surface water and groundwater monitoring network will be incorporated into the Napa Valley Subbasin integrated hydrologic model (NVIHM) to quantify the volumetric exchanges between surface water and groundwater. The NVIHM is a necessary tool for the NCGSA to calibrate and apply the required methods to calculate depletion of surface water caused by

groundwater extraction. Coupled with the best available hydrologic data for the entire Subbasin, the NVIHM will better inform the NCGSA of any additional data gaps that have not yet been identified.

5.9.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

The NCGSA has identified data gaps in the interconnected surface water and groundwater monitoring network for the Napa Valley Subbasin and has summarized the information in **Table 5-14**. Data gaps in the network will be reevaluated after calibration of the NVIHM.

Table 5-14: Data Gaps in the Interconnected Surface Water and Groundwater Monitoring Network

Data Gap Type	Applicable Sites
Insufficient spatial coverage	Overall Network

5.9.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

The NCGSA currently plans to construct 4 new dual completion dedicated monitoring wells within the Subbasin to further characterize the relationship between surface water and groundwater conditions. The NCGSA has already identified the locations of where to construct the new dedicated monitoring sites, shown in **Figure 5-2**, in which the following rationale was considered during the site selection process:

- Prioritized sites that are not currently represented by the geologic and hydrologic conditions of the current dedicated monitoring sites in the network
- Prioritized locations of increased groundwater extraction
- Prioritized sites in the vicinity of the Napa River or one of its tributary streams
- Prioritized sites in the vicinity of GDEs
- Prioritized site accessibility to assure well construction was feasible

Expanding on the scientific rationale described above, the NCGSA identified specific data gaps in the Northeast Napa management area, upper valley, and southern extent of the Subbasin. A site proposed in the Northeast Napa management area is intended to further characterize its distinctive conditions that are independent from the overall Subbasin. Detailed in the *Northeast Napa Area: Special Groundwater Study* (LSCE, 2017), the management area is typified by several faults that influence streamflow conditions and the behavior of groundwater levels in response to pumping. Data collected from this site will further refine management actions already in place within the area and will allow the

NCGSA to implement the necessary sustainability criteria to protect the area from depletion of interconnected surface waters in response to groundwater extraction.

The current monitoring network does not encompass the upper northern extent of the Subbasin or proportionately represent perennial reaches of the Napa River and its tributaries. Therefore, the NCGSA has proposed two sites in the upper valley region. One site is specifically located between two perennial streams, while the other, located south near Rutherford, is specifically located in an area of the Subbasin that experiences the highest concentration of groundwater extraction, described in **Section 7**.

Lastly, the monitoring site proposed south of the City of Napa is located along a tidal-dominated portion of the Napa River in the vicinity of classified groundwater dependent ecosystem (GDE) wetland habitat. Depositional deposits in this area are mostly fine-grained silt, sand, and clay floodplain sediments that extend to the south and shift to marshland and estuary sediments. Well control is lacking in this area of the Subbasin, which has also impacted the availability of existing wells to incorporate into the seawater intrusion monitoring network, described in **Section 5.6**. The addition of a monitoring site in the southern area of the Subbasin will improve the NCGSA's understanding of interconnected surface water and groundwater and its relationship with GDEs.

Overall, the data collected from the 4 proposed monitoring sites will fill current spatial gaps in the monitoring network.

5.10. Stream Stage and Stream Discharge Monitoring Network

Monitoring of stream stage and stream discharge is an essential component in characterizing the relationship between interconnected surface water and groundwater. In addition to the interconnected surface water and groundwater monitoring network and the surface water quality monitoring network, the spatial and temporal changes in stream stage and discharge can be related to other hydrologic indicators and provide the data necessary to calculate the volumetric depletions of surface waters caused by groundwater extractions. The NCGSA conducts a small degree of stream stage monitoring within the Plan area and incorporates other stage and discharge data collected by the USGS and Napa County Resource Conservation District (NCRCD) into the Subbasin's monitoring network.

In arrangement with existing stream stage and discharge monitoring sites and sites managed by the NCGSA, the objectives of the stream stage and stream discharge monitoring network include:

- Characterize the seasonal hydraulic gradient between the principal aquifer and the stream
- Determine the temporal and spatial relationship between groundwater pumping and stream stage/discharge

5.10.1. Requirements

GSP Regulations do not require the monitoring of stream discharge or stream stage in a GSP, however, stream discharge and stream stage monitoring is necessary for incorporation into a water budget analysis and for use in evaluation of stream depletion associated with groundwater extraction.

5.10.2. Monitoring Protocols

5.10.2.1. Methodology

The NCGSA utilizes measurements of stage and discharge to compute streamflow. DWR refers to procedures outlined in USGS Water Supply Paper 2175, Volume 1. – Measurement of Stage Discharge and Volume 2. – Computation of Discharge for methods to collect, analyze, and report streamflow measurements (Rantz and others, 1982a). The procedures outlined in these manuals describe the following methods for selecting and measuring gage station sites and the various methods of discharge monitoring, including:

- Types of gaging station controls used to convert records to discharge
- Selection of nonrecording and recording stream-gaging stations, and the factors affecting the accuracy of stage recording
- Various methods of measuring stream gage and discharge, including indirect determination of peak discharge
- Various methods of discharge ratings to determine streamflow at a designated stage
- Computing stream discharge

The NCGSA will conduct the appropriate monitoring methods outlined in Rantz and Others (1982a) at their managed sites.

5.10.2.2. Frequency

Per USGS guidelines, a minimum of ten discharge or stream stage measurements are recommended per year, unless it has been demonstrated that a stage-discharge relation is unvarying with time.

5.10.3. Monitoring Network

A supplementary component of the Napa Valley Subbasin's monitoring network for interconnected surface water and groundwater includes a stream stage and stream discharge monitoring network. The stream stage and discharge monitoring network consist of 23 stream sites total, in which 7 sites monitor both stream stage and discharge and 16 sites monitor stream stage only. Deployed in 2015, Napa County deployed 5 transducers programmed to collect stream stage and quality data (temperature, Specific conductance) at 4-hour intervals. These transducers are located adjacent to the 5 dedicated monitoring sites for interconnected surface water and groundwater described in **Section 5.9.** In addition to the NCGSA's 5 stream stage monitoring sites, the NCRCD Flood Watch monitoring network includes 16 sites within the Subbasin monitored at 12-hour intervals and the USGS monitors 2 sites within the Subbasin at 15-minute intervals. **Figure 5-9** shows the location of stream stage and stream discharge

monitoring sites included in the monitoring network and **Table 5-15** summarizes relevant stream site information.

Table 5-15: Napa Valley Subbasin Stream Stage and Stream Discharge Monitoring Network Site Information

Site ID	Site Type	Latitude	Longitude	Stream Measurement Constituent	Period of Record	Monitoring Frequency	Monitoring Entity
NapaCounty-swgw-1	Stream	38.3023470	-122.2787280	Stage	2015 - 2020	4 hours	Napa County
NapaCounty-swgw-2	Stream	38.3650990	-122.3380730	Stage	2015 – 2019	4 hours	Napa County
NapaCounty-swgw-3	Stream	38.3679790	-122.3035560	Stage	2015 – 2020	4 hours	Napa County
NapaCounty-swgw-4	Stream	38.4183160	-122.3518720	Stage	2015 – 2016	4 hours	Napa County
NapaCounty-swgw-5	Stream	38.5111752	-122.4549746	Stage	2015 - 2020	4 hours	Napa County
40127	Stream	38.3036	-122.3312	Stage	2007 - 2020	12 hours	NCRCD
40124	Stream	38.508	-122.3545	Stage	2000 - 2020	12 hours	NCRCD
40103	Stream	38.3104	-122.2775	Stage	2000 - 2020	12 hours	NCRCD
40129	Stream	38.5102	-122.4786	Stage and Discharge	2015 - 2020	12 hours	NCRCD
40104	Stream	38.3151	-122.3338	Stage	2000 - 2020	12 hours	NCRCD
40115	Stream	38.3653	-122.3374	Stage and Discharge	2000 - 2020	12 hours	NCRCD
12	Stream	38.4186	-122.3515	Stage	2000 - 2020	12 hours	NCRCD
40117	Stream	38.3021	-122.3039	Stage	2000 - 2020	12 hours	NCRCD
40128	Stream	38.3284	-122.2899	Stage and Discharge	2008 - 2020	12 hours	NCRCD
40116	Stream	38.4048	-122.3678	Stage	2000 - 2020	12 hours	NCRCD
40141	Stream	38.5052	-122.4639	Stage	2009 - 2020	12 hours	NCRCD
40110	Stream	38.5929	-122.5913	Stage	2000 - 2020	12 hours	NCRCD
40154	Stream	38.5795	-122.5821	Stage	2018 - 2020	12 hours	NCRCD
40142	Stream	38.5688	-122.5551	Stage and Discharge	2009 - 2020	12 hours	NCRCD
40111	Stream	38.5273	-122.4909	Stage	2000 - 2020	12 hours	NCRCD
40144	Stream	38.2897	-122.2651	Stage and Discharge	2011 - 2020	12 hours	NCRCD
11458000	Stream	38.368	-122.302	Stage and Discharge	1929 - 2020	15 minutes	USGS
11456000	Stream	38.511	-122.455	Stage and Discharge	1929 - 2020	15 minutes	USGS

5.10.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the sites selected to monitoring stream stage and stream discharge within the Plan area include:

- Prioritize sites in the vicinity to wells in the interconnected surface water and groundwater monitoring network

- Prioritize sites located on major rivers and streams within the Subbasin

Monitoring of stream stage and discharge is not a requirement under GSP Regulations, however, the framework of a stream stage and stream discharge monitoring network is dependent upon the monitoring objectives and ability to sufficiently characterize the hydrologic conditions of interest. The main objectives of the stream stage and discharge monitoring network support monitoring conducted at the interconnected surface water and groundwater monitoring sites (**Section 5.9**), therefore, the adequacy of this network is determined by its spatial and temporal coverage coincident with this other network. The stream stage and discharge monitoring sites collected by Napa County coincide with the locations of the dedicated monitoring sites within the interconnected surface water and groundwater monitoring network, in which both networks collect groundwater levels and stream stage data at a frequency of every 4 hours. Sites managed by the USGS and NCRCD serve as additional controls to characterize flows in the Subbasin.

5.10.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

5.10.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC, the Napa County Resource Conservation District, and the public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

5.11. Groundwater Dependent Ecosystem Monitoring Network

Described in detail in **Section 6**, the NCGSA considers the presence of GDEs within the Plan area significant enough to designate a monitoring network for this beneficial user of groundwater. The NCGSA has not implemented a GDE monitoring network prior to this Plan and will utilize existing geospatial and remote sensing datasets to support groundwater level monitoring in the Plan area. The overall objectives of the GDE monitoring network includes:

- Monitor changes in the geospatial distribution of GDEs within the Subbasin
- Characterize the relationship and correlations between GDE vegetation metrics with local precipitation and groundwater levels
- Develop a basic understanding of the biologic species characteristic to GDEs within the Subbasin

5.11.1. Requirements

GSP Regulations do not require the monitoring of GDEs in a GSP, however, GDEs must be properly identified within the Plan area utilizing data available from DWR, as specified in GSP Regulation §353.2, or the best information available to the Agency. The location, extent, and characteristics of GDEs are detailed in **Section 6** of the Plan. The following section describes the NCGSA's plan to monitor GDEs

within the Subbasin using BMPs and monitoring methods made available by The Nature Conservancy (TNC) (Rohde et. Al, 2018).

5.11.2. Monitoring Protocols

The NCGSA will utilize four primary methods to monitor GDEs within the Plan area. These methods are coupled with guidance provided by TNC, in cooperation with DWR, and the California Surface Water Ambient Monitoring Program's (SWAMP). The methods outlined in this section apply the following techniques to monitor GDEs:

- Groundwater level monitoring
- Geospatial mapping
- Remote sensing
- Biologic field assessments

5.11.2.1. Methodology

Groundwater level monitoring. The groundwater level monitoring wells selected for monitoring changes in GDEs use the same protocols applied to the groundwater level monitoring network.

Geospatial Mapping. Outlined in TNC's guidance for preparing GSPs considerate of GDEs, TNC provides a systematic and defensible approach to identifying GDEs, determining whether potential effects on GDEs are occurring or may occur due to groundwater conditions, and considering GDEs when formulating sustainable management criteria (Rohde et al., 2018). The methods of identifying GDEs are flexible and depend on the best available science for a specific basin, however, ultimately recommend setting sustainable management criteria based on the conditions necessary to avoid adverse impacts to GDEs and undesirable results in said basin. The components outlined in the TNC's GDE guidance relevant to monitoring the location and extent of GDEs within a Subbasin will be an iterative process revisited on an 5-year schedule, consistent with GSP 5-year update reporting, or when updated mapping is published by a reliable agency, such as TNC or the California Department of Fish and Wildlife (CDFW). Monitoring the location and extent of GDEs within the Subbasin include specific instructions for mapping and characterizing the GDE conditions, described in detail in Rohde et al. (2018), but can be summarized to include the following:

- Utilize the statewide GDE indicators (iGDE) database to build a basemap of GDEs in the Plan area to compare with hydrologic data collected from the various monitoring networks. Hydrologic data from the monitoring networks will vary over time, impacting the occurrence and distribution of GDEs that respond to changes in these networks.
- Further distinguish initial GDE mapping using local aerial imagery and vegetation maps to verify, add, and remove GDE units where applicable.
- Provide an assessment of historical and current GDE conditions as related to the hydrologic and human alteration conditions.

Remote Sensing. Detailed in TNC's report *GDE Pulse: Taking the Pulse of Groundwater Dependent Ecosystems with Satellite Data*, remotely sensed satellite data from NASA's Landsat Program can be applied to monitor the health of vegetation worldwide (Klausmeyer et al., 2019). Landsat imagery is made available at a resolution of 30 meters every 16 days, in which long-term temporal trends of vegetation metrics are made available on TNC's GDE Pulse web app, allowing users to infer the relationships between groundwater levels, precipitation, and GDE vegetation metrics. Detailed in the report, the methods in which TNC processed the satellite data results in a geospatial representation of the Normalized Derived Vegetation Index (NDVI) to estimate vegetation greenness and Normalized Derived Moisture Index (NDMI) to estimate vegetation moisture. TNC provides the average NDVI and NDMI for all Landsat pixels, masked to spatial data from the iGDE database, to present the average and trend geospatial layers representing positive and negative trends in the two vegetation metrics.

Biologic Field Assessments. In addition to monitoring potential changes in the occurrence and distribution of GDEs within the Subbasin, biological assessments are necessary to provide detailed site information for evaluating the potential effects on GDEs, investigating stream habitat conditions, and evaluating the status of rare, threatened, or endangered species. The California Surface Water Ambient Monitoring Program's (SWAMP) *Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* provides methods for assessing the ecological conditions of wadeable streams and rivers based on the composition of the benthic macroinvertebrate and benthic algal assemblages (Ode, 2016). The procedures also produce standardized measurements of instream and riparian habitat and ambient water chemistry to support interpretation of the biological data.

[Input from the GSPAC, Napa County Resource Conservation District, and the public is necessary to determine the biologic field assessments necessary and viable for the NCGSA to implement within the Plan area.]

5.11.2.2. Frequency

GSP Regulations do not provide explicit monitoring frequency requirements specific to GDEs, however, the NCGSA has committed to reassessing the geospatial extent of GDEs at a minimum of every 5 years, presenting updated remote sensing data when made available, and performing biological monitoring within GDE units at the designated schedule. The groundwater level wells selected for monitoring changes in GDEs will use the same protocols of monitoring frequency applied to the groundwater level monitoring network.

5.11.3. Monitoring Network

The GDE monitoring network will include monitoring of groundwater levels, spatial mapping, remote sensing data, and biological monitoring. There are 27 wells that make up the GDE groundwater level monitoring network. This includes the entirety of wells in the interconnected surface water and groundwater monitoring network, including well NapaCounty-220s that is located adjacent to the Napa River Ecological Preserve potential GDE Unit along the Napa River, and 2 wells from the groundwater level monitoring network. **Figure 5-10** shows the location of the GDE groundwater level monitoring

network and an attribute table of relevant well information is shown in **Table 5-16**. Additionally, **Figure 5-10** shows the current distribution of GDEs the NCGSA has mapped following guidance from TNC and the spatial coverage of processed Landsat data provided by TNC.

Table 5-15: Napa Valley Subbasin GDE Groundwater Level Monitoring Network Well Information

Well ID	CASGEM ID	Well Type	Latitude	Longitude	Aquifer	Well Depth (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Period of Record	Monitoring Frequency	Monitoring Entity
06N04W17A001M	383721N1223189W001	Domestic	38.3721	-122.319	Qa	250			1949 - 2020		DWR
06N04W19B001M	383554N1223441W001	Irrigation	38.3554	-122.344		125			1952 - 2011		DWR
06N04W26N001M	383327N1222806W001	Domestic	38.3327	-122.281		150			1950 - 1971		DWR
06N04W27L002M	383359N1222916W001	Domestic	38.3359	-122.292	Qa	120	60	120	1966 - 2020		DWR
07N05W08M001M	384726N1224499W001	Domestic	38.4726	-122.45		155			1962 - 1978		DWR
07N05W09Q002M	384635N1224182W001	Unused	38.4635	-122.418	Not Defined	232			1949 - 2020		DWR
07N05W10C001M	384774N1224038W001	Irrigation	38.4774	-122.404		30			1930 - 1978		DWR
07N05W22H001M	384445N1223965W001	Domestic	38.4445	-122.397		100			1962 - 1978		DWR
07N05W25A001M	384354N1223553W001	Domestic	38.4354	-122.355		56			1949 - 1978		DWR
08N06W10Q001M	385529N1225106W001	Unused	38.5529	-122.511	Not Defined	200			1949 - 2020		DWR
08N06W14Q001M	385391N1224908W001	Domestic	38.5391	-122.491		22			1949 - 1978		DWR
09N07W25N002M	385927N1225928W001	Unused	38.5927	-122.593		26			1949 - 1978		DWR
NapaCounty-128	385791N1225636W001	Unused	38.57935	-122.563	Qa	50			1962 - 2020		Napa County
NapaCounty-133	384116N1223530W001	Domestic	38.41158	-122.352	Qa	120	20	120	1978 - 2020		Napa County
NapaCounty-135	383554N1223441W001	Irrigation	38.3554	-122.344	Qa, Tsv	125			1979 - 2020		Napa County
NapaCounty-203			38.56218	-122.535	Qa	180			2014 - 2015	Semi-Annual	Napa County
NapaCounty-214s-swgw1	383022N1222784W001	Monitoring Well	38.30216	-122.278	Qa	53	30	50	2014 - 2020	Semi-Annual	Napa County
NapaCounty-215d-swgw1	383022N1222784W002	Monitoring Well	38.30216	-122.278	Qa	98	75	95	2014 - 2020	Semi-Annual	Napa County
NapaCounty-216s-swgw2	383652N1223375W001	Monitoring Well	38.36516	-122.337	Qa	50	25	45	2014 - 2020	Semi-Annual	Napa County
NapaCounty-217d-swgw2	383652N1223375W002	Monitoring Well	38.36516	-122.337	Qa	86	71	81	2014 - 2020	Semi-Annual	Napa County

NapaCounty-218s-swgw3	383674N1223046W001	Monitoring Well	38.36743	-122.305	Qa	40	25	35	2014 - 2020	Semi-Annual	Napa County
NapaCounty-219d-swgw3	383674N1223046W002	Monitoring Well	38.36743	-122.305	Qa	93	78	88	2014 - 2020	Semi-Annual	Napa County
NapaCounty-22		Domestic	38.29604	-122.225		135			2000 - 2020	Semi-Annual	Napa County
NapaCounty-220s-swgw4	384176N1223527W001	Monitoring Well	38.41759	-122.353	Qa	45	25	40	2014 - 2020	Semi-Annual	Napa County
NapaCounty-221d-swgw4	384176N1223527W002	Monitoring Well	38.41759	-122.353	Qa	85	70	80	2014 - 2020	Semi-Annual	Napa County
NapaCounty-222s-swgw5	385110N1224564W001	Monitoring Well	38.51095	-122.456	Qa	40	25	35	2014 - 2020	Semi-Annual	Napa County
NapaCounty-223d-swgw5	385110N1224564W002	Monitoring Well	38.51095	-122.456	Qa	100	80	95	2014 - 2020	Semi-Annual	Napa County

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Reconnaissance-level biological surveys will be conducted every five years to document ecological condition of each GDE unit to better understand site specific conditions. The specific locations at which biological assessments will be consistently monitored have not yet been determined and will be chosen based on ecologic significance and stakeholder input. Biological data will be analyzed in conjunction with hydrological data, where available, to assess potential ecological effects related to changes in groundwater levels and the relative degree of influence on GDE conditions exerted by stream flows and groundwater levels associated with each potential GDE.

[*Monitoring Network* will be revisited following input from the GSPAC, the Napa County Resource Conservation District, and the public.]

5.11.4. Monitoring Network Assessment

In accordance with GSP Regulations §354.34(g)(1), the scientific rationale for the groundwater level monitor sites selected to monitoring GDEs within the Plan area include:

- Prioritized wells that are already included in the interconnected surface water and groundwater monitoring network or the groundwater level monitoring network
- Prioritized sites in the vicinity of the Napa River or one of its tributary streams
- Prioritized sites in the vicinity of GDEs
- Dedicated monitoring sites are dual completion wells, offering greater aquifer representation
- Non-dedicated monitoring wells included in the network have monitoring records of at least 20 years
- A majority of the wells have known construction and aquifer completion information
- Groundwater use in surrounding wells in the area is at a minimum

The overall spatial density of the GDE monitoring network is approximately 38 wells per 100 square miles. Within the Plan area, the occurrence of GDEs are mostly concurrent with riparian woodlands along the Napa River and its tributary streams and freshwater marshlands in the southern area of the Subbasin. The Subbasin lacks existing wells located within any of the GDE units, noted in **Figure 5-8**, therefore GDE groundwater level monitoring sites utilize the nearest existing wells in the vicinity of GDEs.

The purpose of coupling groundwater level, biologic, geospatial, and remote sensing monitoring is to detect ecologic changes in GDEs as a result of hydrologic changes within the Subbasin. Data provided by these networks will allow the NCGSA to monitor impacts to GDEs and environmental surface water users, as detected by biological responses, to evaluate cause-and-effect relationships with groundwater conditions.

5.11.5. Data Gaps

[Data gaps will be revisited following completion of the Napa Valley Subbasin Integrated Groundwater Flow Model to help identify where more monitoring/well control is needed.]

Data gaps identified at any of the groundwater level monitoring sites (Section 5.4) that are currently incorporated into the GDE groundwater level monitoring network, carry over to the wells included in the GDE groundwater level monitoring network as well.

Without proper coupling of data collected from the GDE groundwater level monitoring network with geospatial mapping, remote sensing, and biologic field assessments, the NCGSA cannot currently determine the presence of data gaps in the overall GDE monitoring network.

5.11.6. Proposed Actions to Address Data Gaps

[Both *Data Gaps* and *Proposed Actions to Address Data Gaps* will be revisited following input from the GSPAC and public. Public input is encouraged and extremely valuable in devising an effective monitoring network that will detect hydrologic changes in the Subbasin and inform adaptive management.]

The NCGSA will have a better understanding of the proposed GDE monitoring network's ability to properly characterize the hydrologic and biologic conditions of GDE units within the Plan area after 5 years of data collection following the submittal of this Plan. The NCGSA will provide an assessment of the network, its data gaps, and proposed actions to address data gaps in the 5-year update of this Plan.

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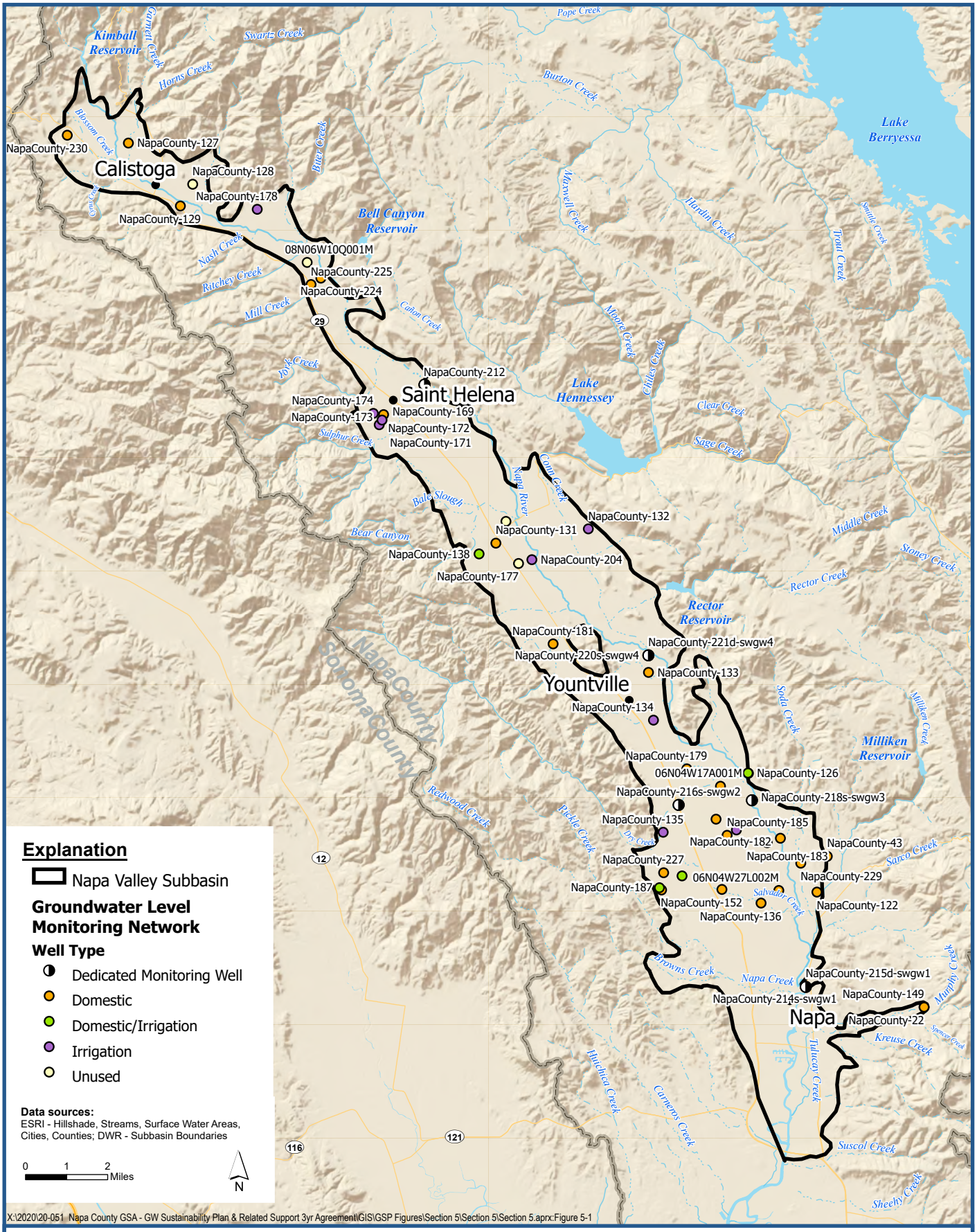
FIGURES



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Napa Valley Subbasin Groundwater Level Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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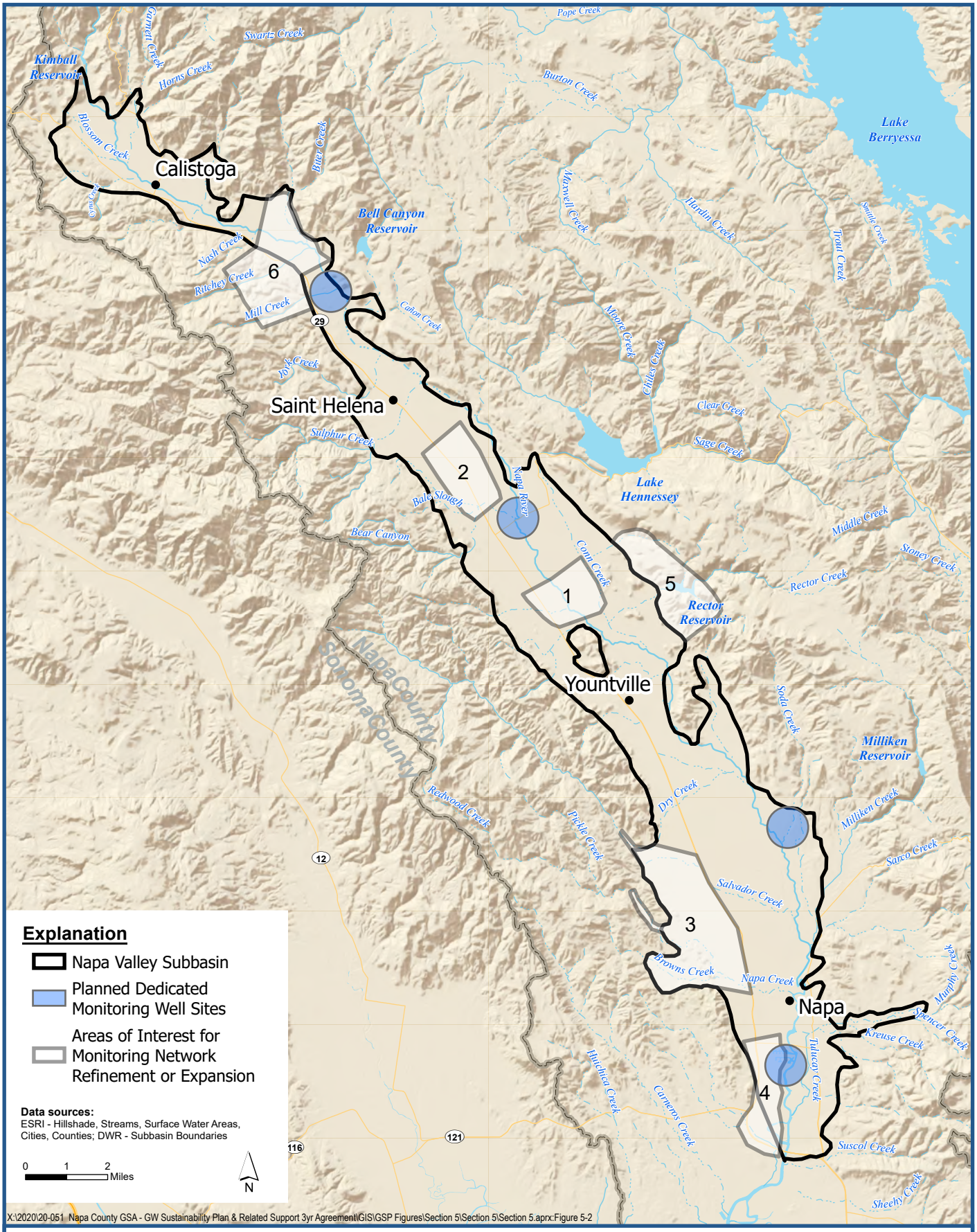
Figure 5-1



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Planned Groundwater Level Monitoring Wells and Areas for Monitoring Expansion

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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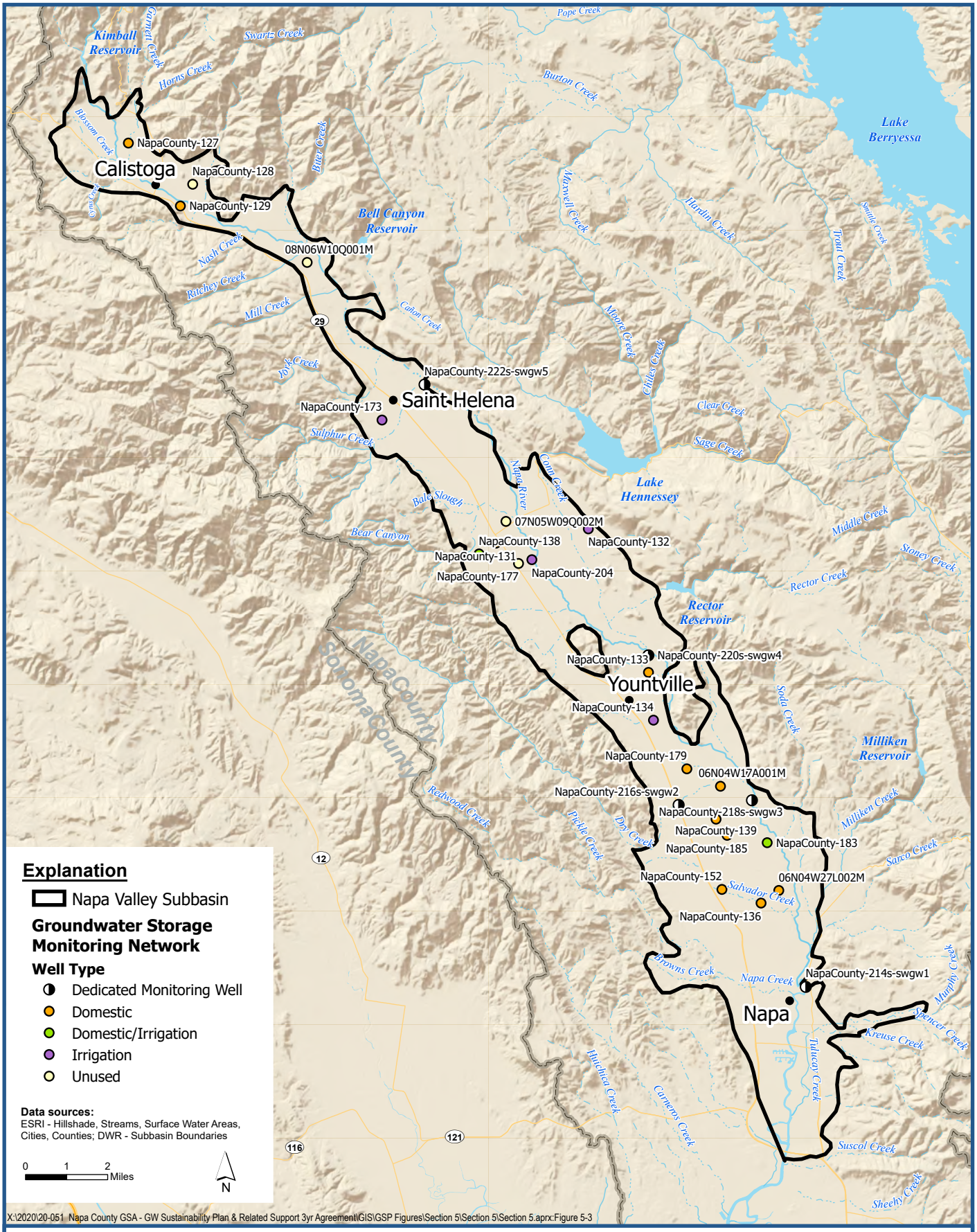
Figure 5-2



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Napa Valley Subbasin Groundwater Storage Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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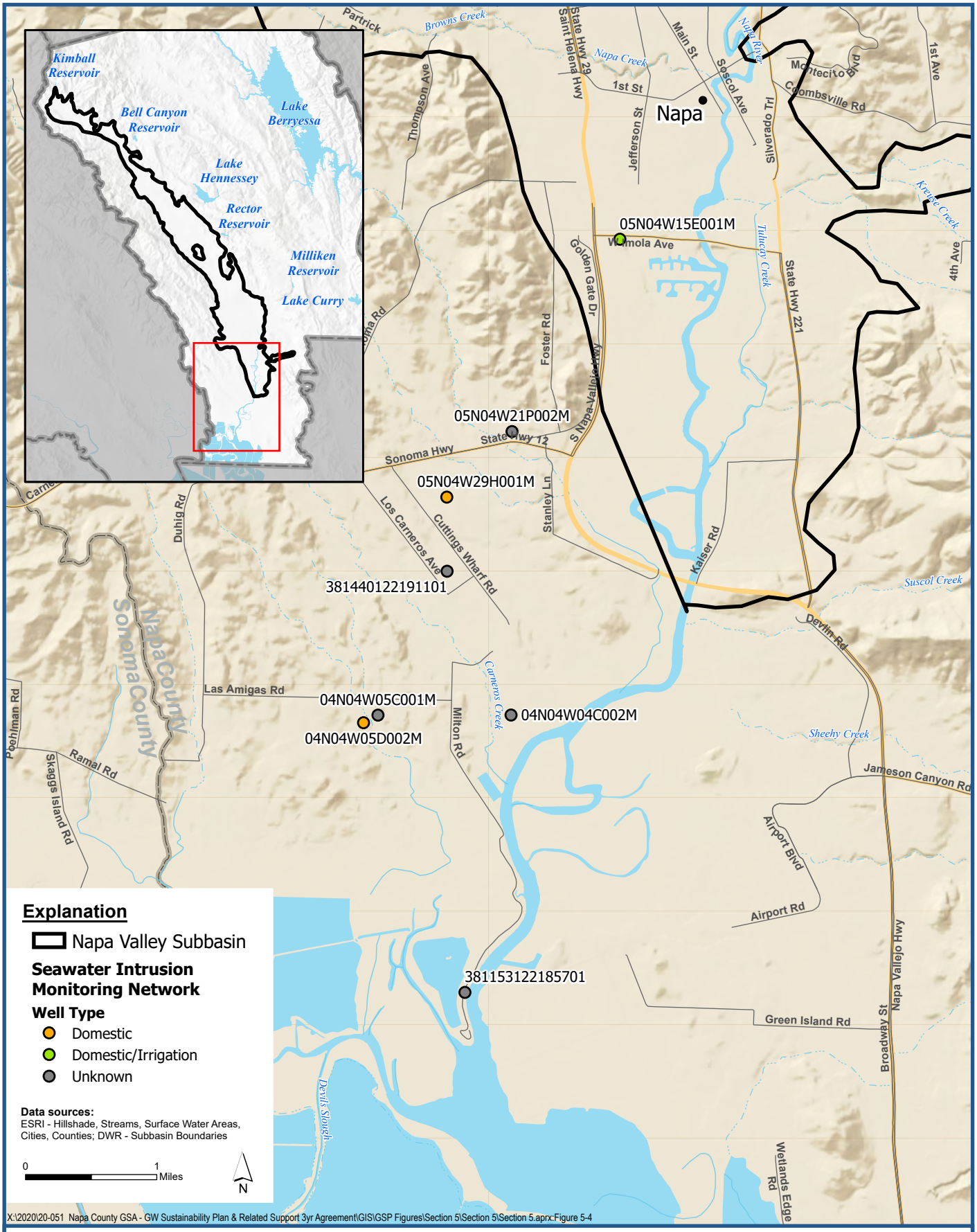
Figure 5-3



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Napa Valley Subbasin Seawater Intrusion Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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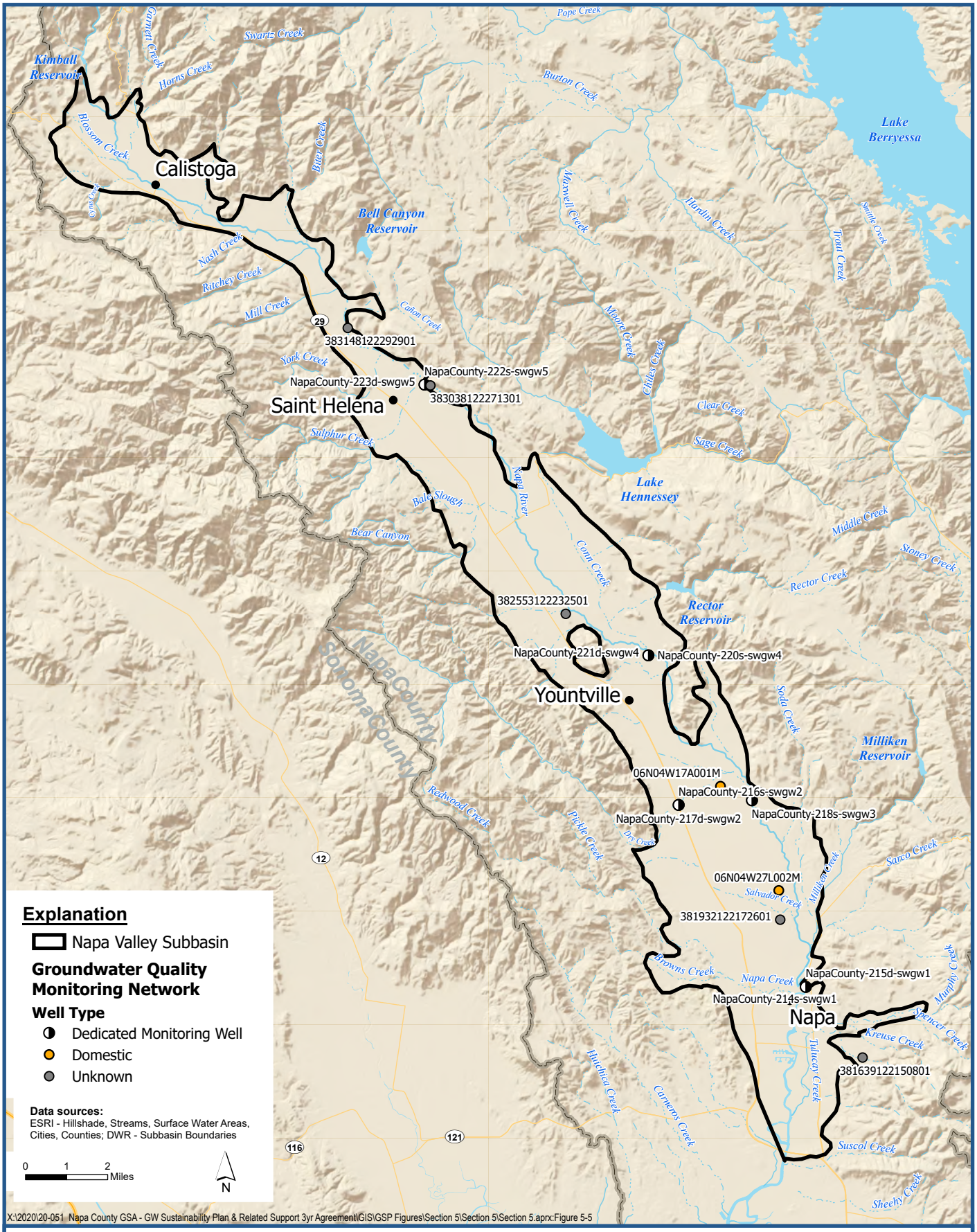
Figure 5-4



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Napa Valley Subbasin Groundwater Quality Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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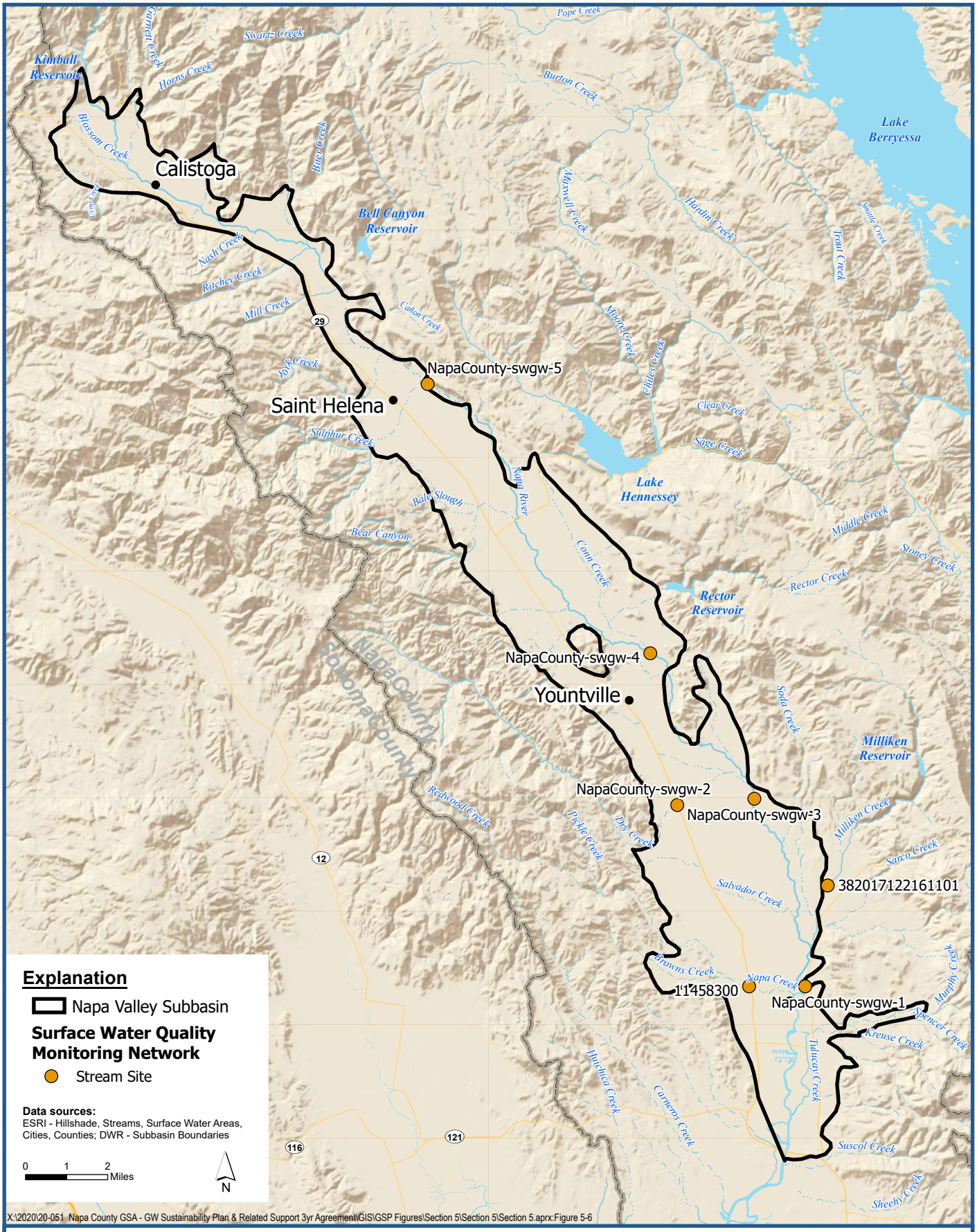
Figure 5-5



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Napa Valley Subbasin Surface Water Quality Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
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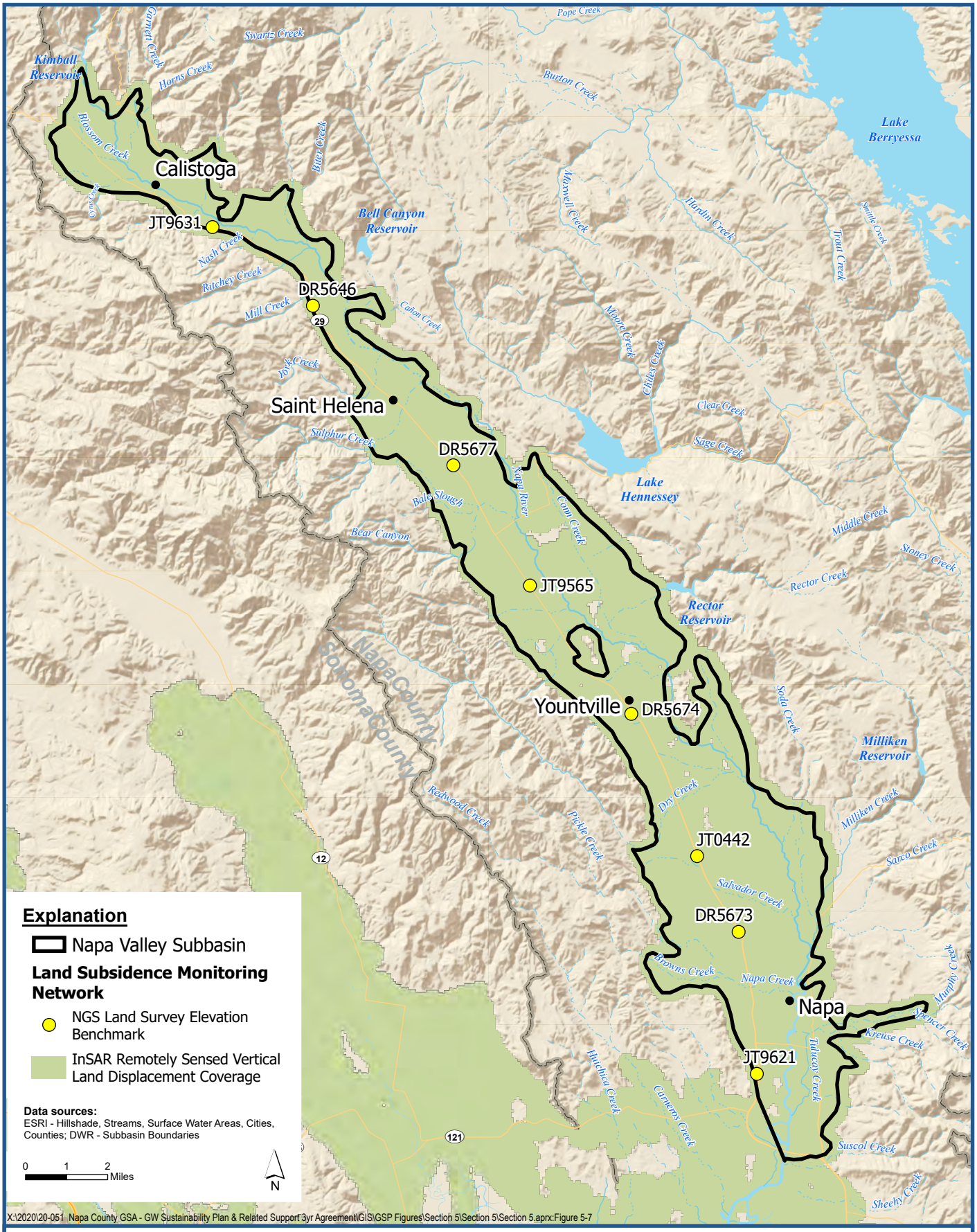
Figure 5-6



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Napa Valley Subbasin Land Subsidence Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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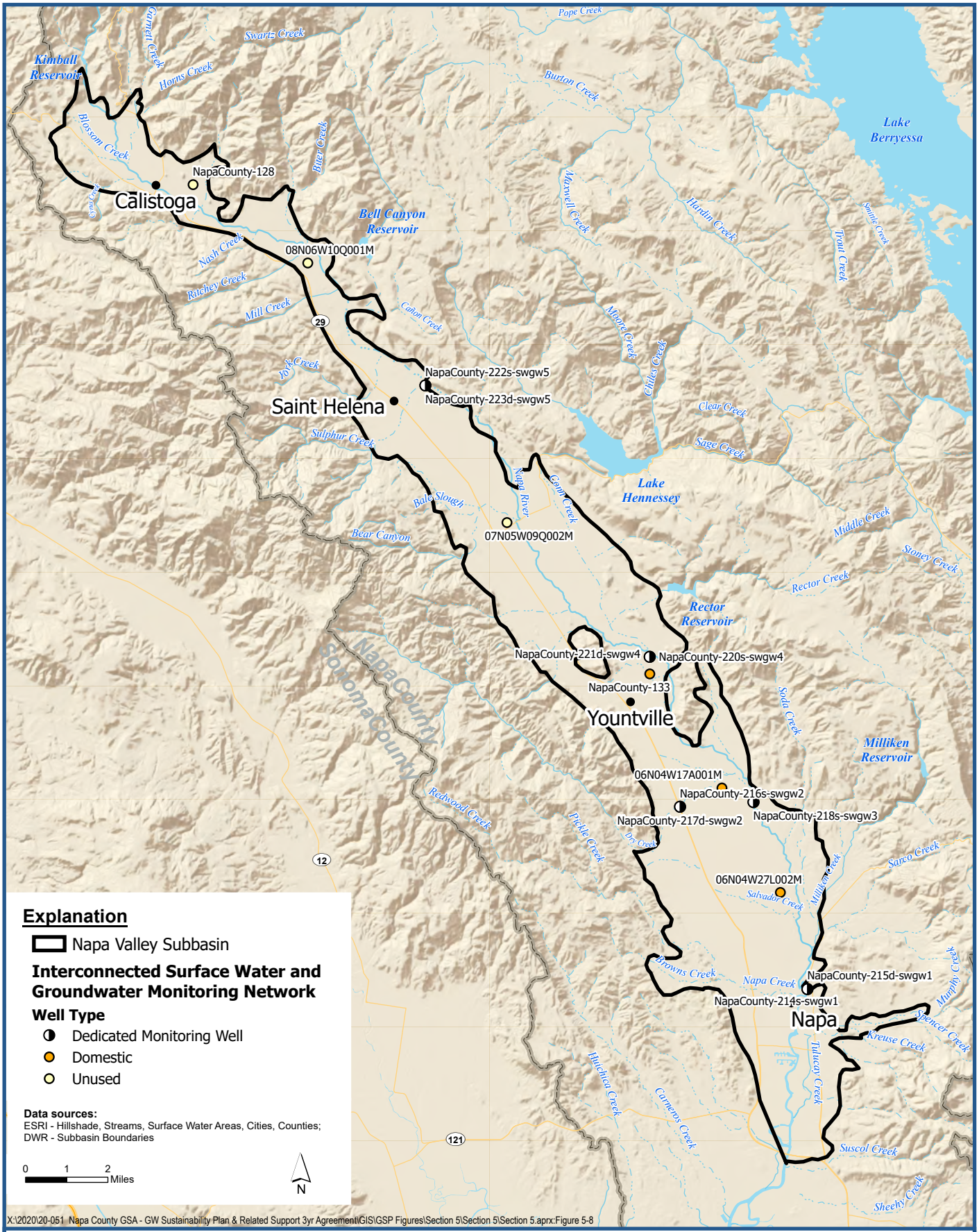
Figure 5-7



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Napa Valley Subbasin Interconnected Surface Water and Groundwater Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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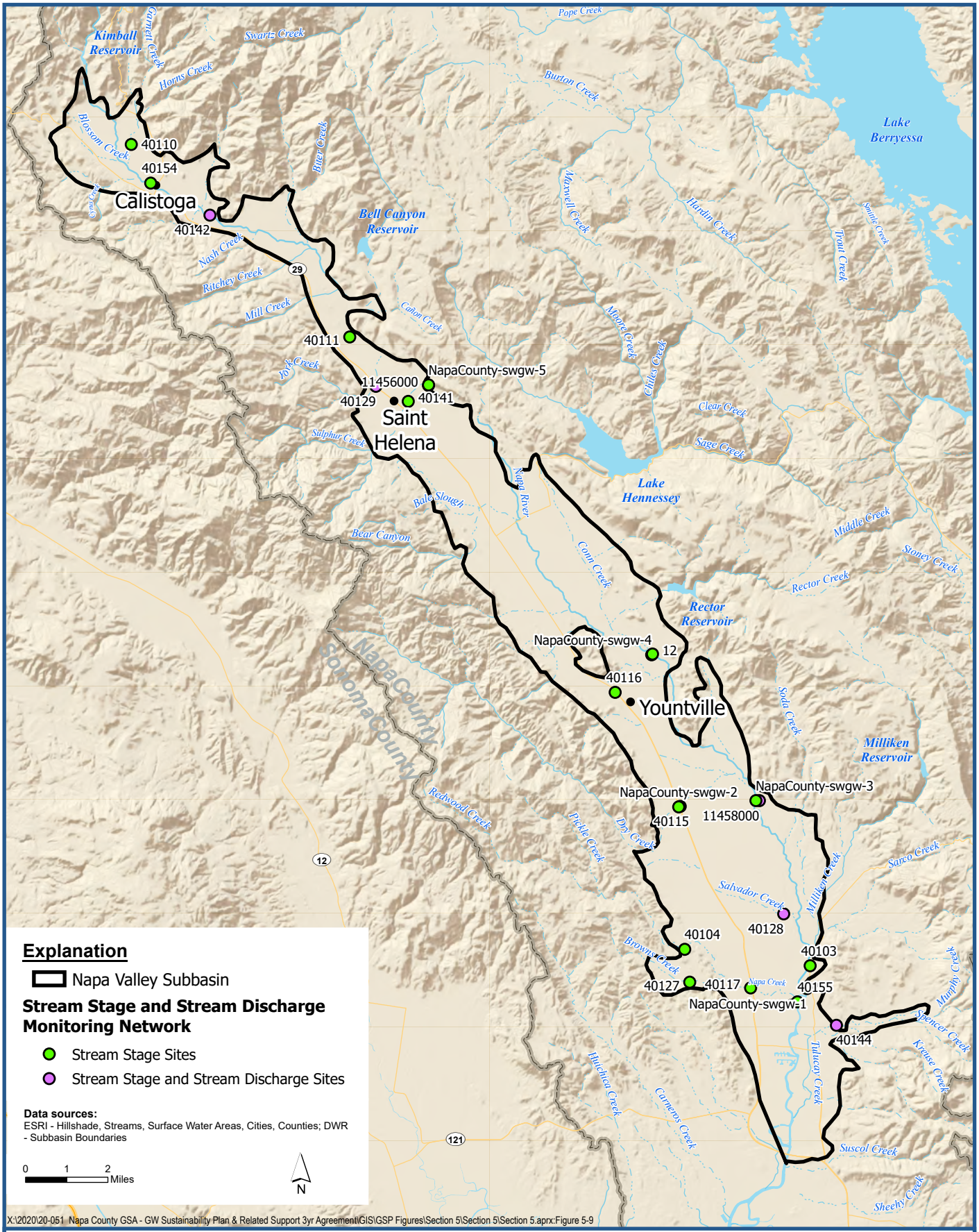
Figure 5-8



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Napa Valley Subbasin Stream Stage and Stream Discharge Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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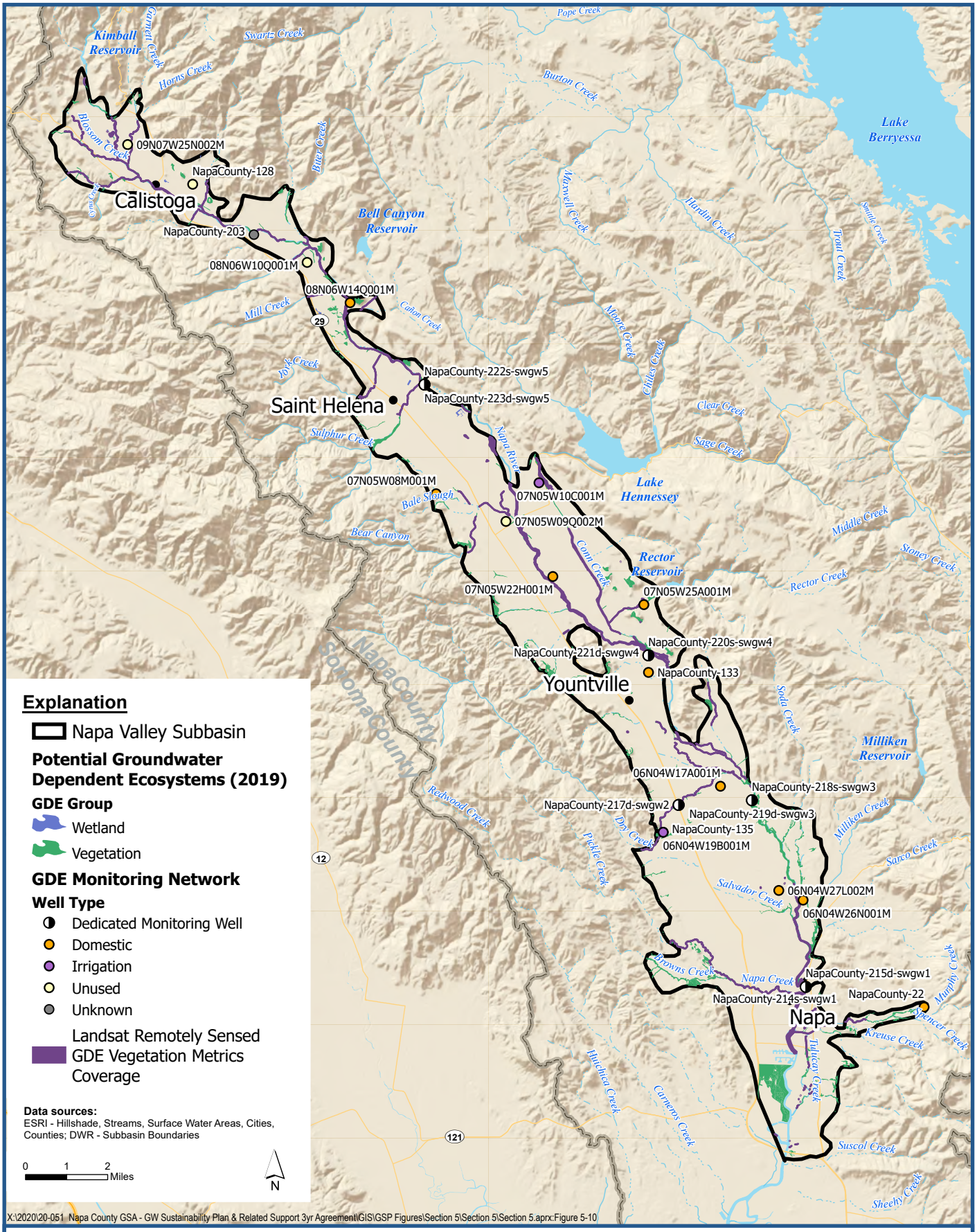
Figure 5-9



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Napa Valley Subbasin Groundwater Dependent Ecosystem (GDE) Monitoring Network

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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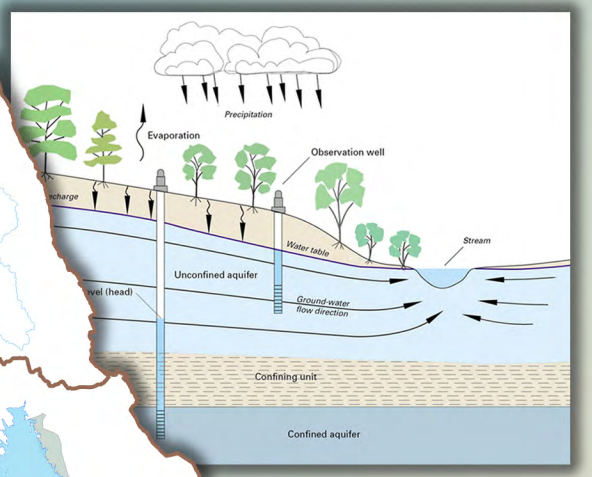
Figure 5-10

APPENDIX 5A

Napa County Groundwater Monitoring Plan (2013)

Napa County Groundwater Monitoring Plan 2013



January, 2013

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CONSULTING ENGINEERS

Napa County

Groundwater Monitoring Plan 2013

January, 2013

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CONSULTING ENGINEERS

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EXECUTIVE SUMMARY

Groundwater and surface water are highly important natural resources in Napa County. Long-term, systematic monitoring programs are essential to provide data that allow for improved evaluation of water resources conditions and to facilitate effective water resources planning. In 2009, Napa County embarked on a countywide project referred to as the "Comprehensive Groundwater Monitoring Program, Data Review, and Policy Recommendations for Napa County's Groundwater Resources" (Comprehensive Groundwater Monitoring Program), to meet identified action items in the 2008 General Plan update. The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information.

The purpose of this *Napa County Groundwater Monitoring Plan 2012* (Plan) is to formalize and augment current groundwater monitoring efforts [levels and quality] to better understand the groundwater resources of Napa County, aid in making the County eligible for public funds administered by the California Department of Water Resources (DWR), and regularly evaluate trends to identify changes in levels and /or quality and factors related to those changes that warrant further examination to ensure sustainable water resources. The Plan is considered a living document that will be updated based upon the data collected and County/community needs. It is envisioned that groundwater conditions and recommended modifications to the countywide groundwater monitoring program would be reported triennially or as needed.

Recent studies by Napa County have found that there are many areas in the county where further efforts to establish or refine groundwater monitoring, using existing or new monitoring facilities, will improve the understanding of groundwater resource conditions and availability. This Plan summarizes groundwater monitoring priorities and recommendations for addressing these priorities. This Plan also summarizes the overarching groundwater level and quality monitoring objectives defined by the County and the Groundwater Resources Advisory Committee (GRAC).

Existing groundwater level and quality monitoring sites are described and recommendations are made for additional monitoring locations of interest to fill data gaps. As additional monitoring sites are considered, or existing monitoring facilities are further evaluated, the groundwater level and quality monitoring objectives will be used to evaluate the suitability of the existing or proposed facilities to ensure that the data being (or planned to be) collected can address these objectives.

The recommended monitoring sites can be addressed in several ways, including:

1) Investigating the potential to restart monitoring where historical records are available but monitoring was discontinued;
2) identifying existing wells of suitable construction that might be volunteered for inclusion through County and GRAC education and outreach efforts (this may include wells that are already being monitored for groundwater quality); and
3) Constructing new dedicated monitoring wells if suitable existing wells either do not exist in the area of interest or are otherwise not available.

This Plan includes recommendations for 18 areas of interest for focused education and outreach efforts to identify existing wells suitable for meeting the monitoring objectives. Additionally, this Plan describes six groundwater monitoring sites located along the main Napa Valley Floor from the City of Napa north to St. Helena adjacent to the Napa River system. These recommended sites would provide the necessary information to further characterize in greater detail the interrelationship between groundwater and surface water resources.

1 INTRODUCTION

1.1 Purpose

Groundwater and surface water are highly important natural resources in Napa County. Collectively, the County and other municipalities, water districts, commercial and industrial operations, the agricultural community, and the general public, are stewards of the available water resources. Currently, municipal and private stakeholders are actively engaged in assessing the reliability of current and future demands and supplies. Important sources of water include both groundwater and surface water of good quality and quantity, to meet future urban, rural, and agricultural water demands. Similar to other areas in California, businesses and residents of Napa County face many water-related challenges including:

- Increased competition for current and future available supplies;
- Preserving the quality and availability of local and imported water supplies;
- Sustaining groundwater recharge capacity and supplies;
- Meeting challenges arising during drought conditions;
- Avoiding environmental effects due to water use; and
- Changes in long-term availability due to global warming and/or climate change.

To address these challenges, long-term, systematic monitoring programs are essential to provide data that allow for improved evaluation of water resources conditions and to facilitate effective water resources planning. Establishment of a groundwater and surface water monitoring network results in the collection of data necessary to distinguish long-term trends from short-term fluctuations, anticipate unintended consequences due to current and historical land uses, identify emerging issues, and design appropriate water resources planning and management strategies. In 2009, Napa County embarked on a countywide project referred to as the "Comprehensive Groundwater Monitoring Program, Data Review, and Policy Recommendations for Napa County's Groundwater Resources" (Comprehensive Groundwater Monitoring Program), to meet identified action items in the 2008 General Plan update. The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information.

The purpose of this *Napa County Groundwater Monitoring Plan 2012* (Plan) is to formalize and augment current groundwater monitoring efforts [levels and quality] to better understand the groundwater resources of Napa County, aid in making the County eligible for public funds administered by the California Department of Water Resources (DWR), and regularly evaluate trends to identify changes in levels and /or quality and factors related to those changes that warrant further examination to ensure sustainable water resources. The Plan is considered a living document that will be updated based upon the data collected and County/community needs. It is envisioned that groundwater conditions and recommended modifications to the countywide groundwater monitoring program would be reported triennially or as needed.

1.2 Organization of the Plan

This Plan formalizes recommendations provided in the County's Comprehensive Groundwater Monitoring Program by outlining steps to augment countywide groundwater level and quality monitoring. Recent studies by Napa County have found that there are many areas in the county where further efforts to establish or refine groundwater monitoring, using existing or new monitoring facilities, will improve the understanding of groundwater resource conditions and availability. This Plan summarizes groundwater monitoring priorities and recommendations for addressing these priorities. This Plan also summarizes the overarching groundwater level and quality monitoring objectives defined by the County and the GRAC. These objectives provide the framework necessary to ensure that the data collected from the countywide monitoring facilities can address these objectives.

On June 28, 2011, the County Board of Supervisors adopted a resolution establishing a Groundwater Resources Advisory Committee (GRAC). Two of the tasks assigned to the GRAC include: 1) assisting with the synthesis of the existing groundwater information and identifying critical data needs; and 2) providing input on the furtherance of the ongoing countywide groundwater monitoring program. During preparation of this Plan, input from this committee is being coordinated to optimize additional groundwater monitoring locations that serve to meet the objectives of the County's Comprehensive Groundwater Monitoring Program and the California Statewide Groundwater Elevation Monitoring (CASGEM) program. As explained in the next section, the CASGEM program is a subset of the countywide groundwater monitoring program.

This Plan includes the following sections:

Section 2: Hydrogeology of Napa County

- DWR Basins/Subbasins and County Subareas
- Summary of Geology and Groundwater Resources
- Overview of Recent Groundwater Studies and Programs
- Presentation of Groundwater Monitoring Priorities
    - Groundwater Level Monitoring
    - Groundwater Quality Monitoring
- Summary of Recommendations from Recent County Studies

Section 3: Groundwater Resources Goals and Monitoring Objectives

- Napa County Water Resources Goals and Policies
- Groundwater Level Monitoring Objectives
- Groundwater Quality Monitoring Objectives
- Funding and Collaboration for Groundwater Monitoring

Section 4: Groundwater Monitoring Network Design and Development

- **Groundwater Level Monitoring** - Monitoring Network (including existing groundwater level monitoring wells, recommendations to expand the monitoring well network, frequency of monitoring, and field methods)

- **Groundwater Quality Monitoring** - Monitoring Network (including existing groundwater quality monitoring wells, recommendations to expand the monitoring well network, frequency of monitoring, field methods, and parameters of interest)

Section 5: Groundwater Data Management

- Data Management Overview
- Data Management System (DMS)
- Data Use and Disclosure

Section 6: Reporting and Assessment

- Annual Update and Review of Monitoring Plan and Well Network
- Annual CASGEM Reporting
- Triennial Countywide Reporting

2 HYDROGEOLOGY OF NAPA COUNTY

This section summarizes the countywide geologic and hydrologic setting, and includes information about DWR groundwater basin/subbasin delineations and a description of the Napa County groundwater monitoring subareas. The studies that form the basis of the understanding of County hydrogeology are referenced, including the work for the Updated Conceptualization and Characterization of Hydrogeologic Conditions (LSCE and MBK, 2013 in progress).

2.1 DWR Basins/Subbasins and County Subareas

DWR has identified the major groundwater basins and subbasins in and around Napa County; these include the Napa-Sonoma Valley (which in Napa County includes the Napa Valley and Napa-Sonoma Lowlands Subbasins), Berryessa Valley, Pope Valley, and a small part of the Suisun-Fairfield Valley Groundwater Basins (**Figure 2-1**). These basins and subbasins are generally defined based on boundaries to groundwater flow and the presence of water-bearing geologic units. These groundwater basins defined by DWR are not confined within county boundaries, and DWR-designated "basin" or "subbasin" designations do not cover all of Napa County.

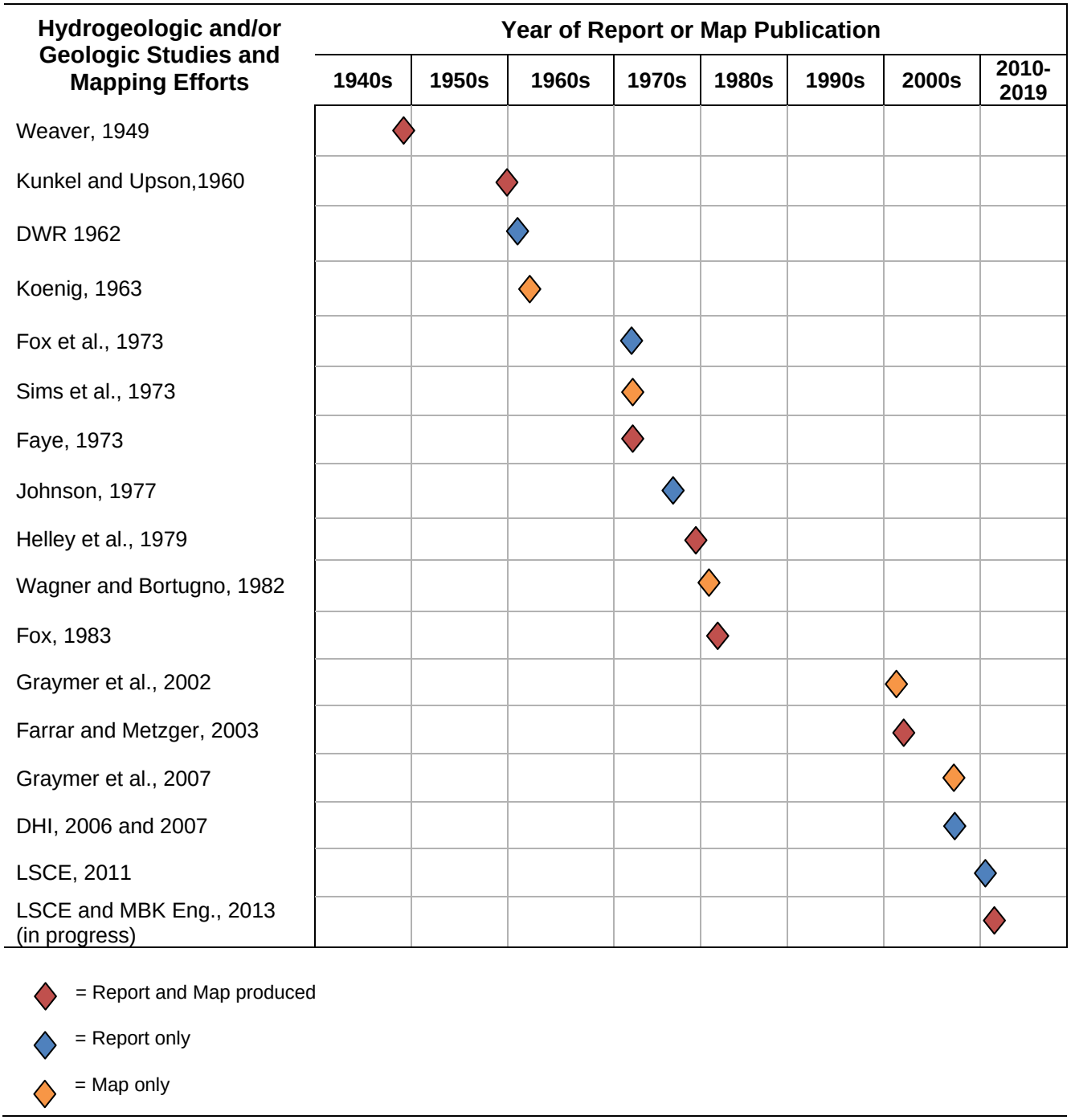
Groundwater conditions outside of the DWR-designated areas are also very important in Napa County. An example of such an area is the Milliken-Sarco-Tulucay (MST) area, a locally identified groundwater deficient area. For purposes of local planning, understanding, and studies, the County has been subdivided into a series of groundwater subareas (**Figure 2-2**). These subareas were delineated based on the main watersheds, groundwater basins, and the County's environmental resource planning areas. These subareas include the Knoxville, Livermore Ranch, Pope Valley, Berryessa, Angwin, Central Interior Valleys, Eastern Mountains, Southern Interior Valleys, Jameson/American Canyon, Napa River Marshes, Carneros, Western Mountains Subareas and five Napa Valley Floor Subareas (Calistoga, St. Helena, Yountville, Napa, and MST).

2.2 Summary of Geology and Groundwater Resources

2.2.1 Previous Studies

Previous hydrogeologic studies of Napa County and also mapping efforts are divisible into geologic studies and groundwater studies. The more significant studies and mapping efforts are mentioned in this section. **Table 2-1** shows the chronological sequence of these efforts that span more than six decades. Weaver (1949) presented geologic maps which covered the southern portion of the county and provided a listing of older geologic studies. Kunkel and Upson (1960) examined the groundwater and geology of the northern portion of the Napa Valley. DWR (Bulletin 99, 1962) presented a reconnaissance report on the geology and water resources of the eastern area of the County; Koenig (1963) compiled a regional geologic map which encompasses Napa County. Fox and others (1973) and Sims and others (1973) presented more detailed geologic mapping of Napa County. Faye (1973) reported on the groundwater of the northern Napa Valley. Johnson (1977) examined the groundwater hydrology of the MST area.

Table 2-1
Summary and Chronology of Hydrogeologic and Geologic Studies and Mapping Efforts in Napa County



Helley and others (1979) summarized the flatland deposits of the San Francisco Bay Region, including those in Napa County. Fox (1983) examined the tectonic setting of Cenozoic rocks, including Napa County. Farrar and Metzger (2003) continued the study of groundwater conditions in the MST area.

Wagner and Bortugno (1982) compiled and revised the regional geologic map of Koenig (1963). Graymer and others (2002) presented detailed geologic mapping of the southern and portions of the eastern areas of the County, while Graymer and others (2007) compiled geologic mapping of the rest of Napa County.

In 2005 to 2007, DHI Water & Environment (DHI) contributed to the 2005 *Napa County Baseline Data Report* (DHI, 2006a and Jones & Stokes et al., 2005) which was part of the County's General Plan update (Napa County, 2008). A groundwater model was developed by DHI in conjunction with the Napa Valley and Lake Berryessa Surface Water models to simulate existing groundwater and surface water conditions on a regional basis primarily in the North Napa Valley and the MST and Carneros Subareas (DHI, 2006b). A 2007 technical memorandum, *Modeling Analysis in Support of Vineyard Development Scenarios Evaluation* (DHI, 2007), was prepared to document the groundwater model update which was used to evaluate various vineyard development scenarios.

Additional geologic maps, groundwater studies, and reports are listed in the references of the Groundwater Report (LSCE, 2011). As recommended in the Groundwater Report and described below, additional work has been conducted to update the conceptualization and characterization of hydrogeologic conditions particularly for the Napa Valley Floor (LSCE and MBK, 2013 in progress).

2.2.2 Summary of Geology and Water Resources

The geology of Napa County can be divided into three broad geologic units based on their ages and geologic nature. These units are: 1) Mesozoic Basement Rocks (pre-65 million years (my)), which underlie all of Napa County, but are primarily exposed in the Eastern County area and the Western Mountains Subarea, 2) Older Cenozoic Volcanic and Sedimentary Deposits (65 my to 2.5 my), including Tertiary Sonoma Volcanics (Miocene and Pliocene; 10 my to 2.5 my) which are found throughout the county, especially in the mountains surrounding Napa Valley, and 3) Younger Cenozoic Volcanic and Sedimentary Deposits (post 2.6 my to present), including the Quaternary alluvium of the Valley Floor. The two primary water-bearing units in the county are the tuffaceous member of the Sonoma Volcanics and the Quaternary alluvium.

Outside of the Napa Valley Floor, percolation of surface water appears to be the primary source of recharge. The rate of recharge within areas such as the MST Subarea has been shown to be significantly higher where streams and tributaries cross highly permeable outcrops (e.g., the tuffaceous member of the Sonoma Volcanics or shallow alluvium). Direct infiltration of precipitation is a major component of recharge in the main Napa Valley. Recharge throughout much of the county is generally limited by underlying shallow bedrock of low permeability. An additional component of groundwater recharge that is less understood is deep percolation through fractured rock and fault zones. This type of recharge can be very difficult to quantify due to the highly variable size and distribution of faults, fractures, and joints in a given area.

Groundwater Occurrence and Quality in the Sonoma Volcanics

Groundwater occurs in the Sonoma Volcanics in Napa County and yields water to wells. Well yields are highly variable from less than 10 to several hundred gallons per minute (gpm). The most common yields are between 10 to 100 gpm. Faye (1973) reported well-test information which showed an average yield of 32 gpm and an average specific capacity of 0.6 gallons per minute per foot of drawdown. From the available well log data, the Tertiary marine sedimentary rocks are poor groundwater producers either for a lack of water or poor water quality (high salinity). At great depths, groundwater quality in the Tertiary marine sedimentary rocks is generally poor due to elevated chloride concentrations.

According to Kunkel and Upson (1960), groundwater in the Sonoma Volcanics is generally of good quality except in three areas. The first area with poor groundwater quality, the Tulucay Creek drainage basin, east of the City of Napa, contains groundwater with elevated iron, sulfate, and boron. The Suscol area, south of the City of Napa, is the second area where some wells exhibit poor quality groundwater due to elevated chloride concentrations, possibly from leakage from salty water in the Napa River, alluvial material above, or the existence of zones of unusually saline connate water deep within the Sonoma Volcanics. The third area of poor groundwater quality, the Calistoga area in the northern end of the Napa Valley, contains isolated wells with elevated chloride, boron, and some trace metal concentrations.

Kunkel and Upson (1960) reported that the principal water yielding units of the Sonoma Volcanics are the tuffs, ash-type beds, and agglomerates. The lava flows were reported to be generally non-water bearing. However, it may be possible that fractured, fragmental, or weathered lava flows could yield water to wells. The hydrogeologic properties of the volcanic-sourced sedimentary deposits of the Sonoma Volcanics are complex and poorly understood.

Groundwater Occurrence in Other Units and in the Quaternary Sedimentary Deposits

Several hundred wells and test holes on record have been drilled into the exposed Huichica Formation. Well yields tend to be low to modest (< 10 gpm to tens of gpm). Only a few known wells on record are completed in the Clear Lake Volcanics near the northern County line. Three wells report high yields of 400 to 600 gpm. Much of the Clear Lake Volcanics to the south appear to be thinner, limited in extent, and in ridge-top locations where possible groundwater production appears to be less likely.

Groundwater production from Quaternary alluvium is variable, with yields ranging from <10 gpm in the East and West mountainous areas to a high of 3,000 gpm along the Napa Valley floor where the alluvium is thickest (>200 feet). According to Faye (1973), average yield of wells completed in the alluvium is 220 gpm. Many wells drilled in the alluvium within the last 30 years extend beyond the alluvium and into the underlying Cenozoic units. Kunkel and Upson (1960) report that groundwater in the alluvium is generally of good quality. The groundwater is somewhat hard and of the bicarbonate type, with small concentrations of sulfate, chloride, and total dissolved solids. A few isolated areas have increased chloride and boron concentrations.

2.3 Recent Groundwater Studies and Programs

This section summarizes the recently completed studies by Napa County and the recommendations relevant to groundwater monitoring that were developed.

2.3.1 Napa County's Comprehensive Groundwater Monitoring Program

In 2009, Napa County implemented a Comprehensive Groundwater Monitoring Program to meet identified action items in Napa County's 2008 General Plan update (Napa County, 2008). The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information. The program (and elements of this Plan) covers the continuation and refinement of countywide groundwater level and quality monitoring efforts (including many basins, subbasins and/or subareas throughout the county) for the purpose of understanding groundwater conditions (i.e., seasonal and long-term groundwater level trends and also quality trends) and availability. This information is critical to enable integrated water resources planning and the dissemination of water resources information to the public and state and local decision-makers. Napa County's combined efforts through the Comprehensive Groundwater Monitoring Program along with the related AB 303 Public Outreach Project on groundwater (CCP, 2010) and the efforts of the Watershed Information Center & Conservancy (WICC) of Napa County create a foundation for the County's continued efforts to increase public outreach and participation in water resources understanding, planning, and management. An informed and engaged public enables support of planned water resources projects and programs proposed by the County and others to meet the goals and objectives discussed in Section 3.

Napa County's Comprehensive Groundwater Monitoring Program involved many tasks that led to the preparation of five technical memorandums and a report on *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (Groundwater Report) (LSCE, 2011a). This report and the other related documents can be found at: http://www.countyofnapa.org/bos/grac/. The report documents existing knowledge of countywide groundwater conditions and establishes a framework for the monitoring and reporting of groundwater levels and groundwater quality on a periodic basis. The report also summarizes priorities for groundwater level and quality monitoring for each of the county subareas.

2.3.2 Napa County Statewide Groundwater Elevation Monitoring (CASGEM)

This section describes the new DWR California Statewide Groundwater Elevation Monitoring (CASGEM) program. The wells included by the County in the CASGEM program are a *subset* of the overall network of wells monitored in Napa County.

In November 2009, Senate Bill SBX7 – 6 mandated that the groundwater elevations in all basins and subbasins in California be regularly and systematically monitored with the goal of demonstrating seasonal and long-term trends in groundwater elevations. In accordance with the mandate, DWR developed the CASGEM program. DWR is facilitating the statewide program which began with the opportunity for local entities to apply to DWR to assume the function of regularly and systematically collecting and reporting groundwater level data for the above purpose. These entities are referred to as Monitoring Entities. The legislature added a key aspect

to SBX7 – 6 which was to make certain elements of the groundwater level information available to the public.

Wells designated for inclusion in the CASGEM program are for purposes of measuring groundwater levels on a semi-annual or more frequent basis that are representative of groundwater conditions in the state's groundwater basins and subbasins.

On December 29, 2010, the County applied to DWR to become the local countywide Monitoring Entity responsible for designating wells as appropriate for monitoring and reporting groundwater elevations for purposes of the CASGEM program.

The wells selected by the County for this program may be a *subset* of the overall wells monitored and need not be inclusive of the County's entire monitoring network. Thus, the County's participation in the CASGEM program complements other pre-existing groundwater monitoring that has been ongoing in Napa County for sometime (the overall historical monitoring record began in 1918). The end goals of the CASGEM program from the state's perspective is to support the understanding, managing, and sustaining of groundwater resources throughout California.

Following confirmation, the County, as the Monitoring Entity, proceeded to identify a *subset* of monitored wells to be included in the CASGEM network and to prepare a CASGEM Network Plan as required by DWR (LSCE, 2011b). At the time the County's CASGEM Network Plan was submitted to DWR, fourteen wells were included in the program. As of June 2012, the number of CASGEM wells had increased to nineteen.

2.3.3 Updated Conceptualization and Characterization of Hydrogeologic Conditions

In 2012, activities were implemented to update the characterization and conceptualization of hydrogeologic conditions (LSCE and MBK Engineers, 2013 in progress). Work to date is summarized below for three tasks, including: 1) the updated Napa Valley geologic conceptualization, 2) linking well construction information to groundwater level monitoring data, and 3) groundwater recharge characterization and estimates.

An important aspect of the work to update the hydrogeologic conceptualization is providing a refined understanding of the mechanisms through which water moves in response to the hydrologic cycle, particularly in the aquifer system underlying the main Napa Valley Floor. This involves many complex pathways and also considers many different time scales. As discussed further below, a key County General Plan goal (Napa County, 2008) is to " Conserve, enhance and manage water resources on a sustainable basis to attempt to ensure that sufficient amounts of water will be available for the uses allowed by this General Plan, for the natural environment, and for future generations." The groundwater monitoring program described in this Plan is instrumental to accomplishing this goal. The groundwater monitoring data (especially levels) are important for understanding the quantity of water flowing into and from a groundwater basin. Construction of a water budget, also known as a water balance, is a tool scientists can employ to assess the quantity of groundwater in storage. This tool is also used to observe how the quantity of groundwater in storage may vary over time. This tool relies upon a defined accounting unit of volume, for example a groundwater basin or other hydrologic unit of analysis. Measurements of

water flowing into and out of the defined unit are used to determine the change in water storage. In the simplest form, the equation for this is:

Inflows – Outflows = Change in Storage

Typical Inflows and Outflows are summarized below (DWR, 2003):

Inflows

- Natural recharge from precipitation;
- Seepage from surface water channels;
- Intentional recharge via ponds, ditches, and injection wells;
- Net recharge of applied water for agricultural and other irrigation uses;
- Unintentional recharge from leaky conveyance pipelines; and
- Subsurface inflows from outside basin boundaries.

Outflows

- Groundwater extraction by wells;
- Groundwater discharge to surface water bodies and springs;
- Evapotranspiration; and
- Subsurface outflow across basin or subbasin boundaries.

Information relating to each of the above inflow and outflow data components provides the best approximation of the change in storage. A simple way of estimating the change in storage in a basin is through the determination of the average change in groundwater elevations over the groundwater basin for a period of time. This change in water levels is then multiplied by the area overlying the basin and also the average specific yield (in the case of an unconfined aquifer system, or storativity in the case of a confined aquifer system). The change in groundwater levels is best determined over a specific study period that considers different water year types (wet, normal, dry, multiple dry years), but it is common for shorter time periods (e.g., one year's spring to spring groundwater elevations) to be used. This simplistic approach to calculating a change in storage does not provide an indication of the total volume of groundwater storage or the storage available for use. Rather, this computation provides a "snapshot" perspective of short-term trends. The quick calculation should only be considered as an indicator; a more complete groundwater balance evaluation is much preferred (e.g., groundwater flow model). For example, if stresses on the aquifer system induce additional surface water infiltration, the change in groundwater storage may not be apparent (DWR, 2003).

Updated Napa Valley Geologic Conceptualization

Published hydrogeologic studies of Napa County have been largely based on pre-1970 water well drillers' reports and focused on the higher yielding Quaternary alluvium deposits of Napa Valley (Kunkel and Upson, 1960; Faye, 1973). Most previous hydrogeologic cross sections have been constructed in the southern portion of the valley near and to the east of the City of Napa (Kunkel and Upson, 1960; Sweetkind and Taylor, 2010; Farrar and Metzger 2003). The northern valley has been characterized by alluvium thickness maps (Faye, 1973) with little attention paid to the older deposits and Sonoma Volcanics.

As part of this investigation, a series of eight cross valley geologic sections were constructed utilizing water well drillers' reports extending up to 2011 (**Figure 2-3**). Cross-section locations were chosen based on perceived geologic relationships and the availability of sufficient well control. About 1,300 water well drillers' reports were reviewed and located on topographic base maps; 191 of these were selected for use in the cross sections. Geologic correlations seen on the cross-sections were then extended between sections by available well control and surficial geologic maps. From the geologic cross-sections and correlations of other water well drillers' reports, the Quaternary alluvium was separated from underlying units, and an isopach (contours of equal thickness) map was constructed.

The alluvium is divided into three facies on the map based on lithologic character. From the area just north of the City of Napa and southward, the alluvium is characterized as the basin fill facies consisting of thin sand and gravels with some thicker channel deposits interbedded with thicker beds of silt and clays of floodplain, marshland and possibly, estuary deposits in the Suscol area. This area is not well defined because of lack of well control. North of this area, the Napa Valley alluvium is subdivided into two facies: the fluvial facies and the alluvial plain facies. A narrow band of the fluvial facies consists of thick-bedded sand and gravel channels with interbedded floodplain silts and clays. The total thickness is up to 300 feet near Yountville and thins southward. The fluvial facies remains thick (up to 200 feet) northward to near Rutherford, and then thins to a thickness of 100 feet or less near the St. Helena area. The area between Rutherford and Oak Knoll Avenue is where the highest well yields are reported. Outside of the fluvial facies towards the valley sides occur the alluvial plain facies of thin sand and gravel beds of tributary streams interbedded with thicker, alluvial fan flood-flow sandy gravelly clays. These deposits appear to thin from a thickness of over 100 feet near the fluvial facies, with which they interfinger, to zero thickness near the valley sides. The alluvial plain facies deposits appear to be modest to low water yielding in pre-1970 wells, but more recently constructed wells extend into deeper units.

Beneath the alluvium is a complex sequence of Tertiary sedimentary deposits (Huichica Formation) and igneous deposits of the Sonoma Volcanics. These units are strongly deformed by folding and faulting and have complex stratigraphic relationships. From the geologic cross-sections, lateral correlations, and surficial map relationships, a structure contour map (elevations) of the top of these units and the subcrop[1] pattern were developed (LSCE and MBK Engineers, 2013 in progress). From north of the City of Napa and southward, these deposits are dominated by fine-grained basin fill with few sand and gravels of floodplain, estuary origin. North towards Yountville, sedimentary deposits of the Huichica Formation appear to overlie Sonoma Volcanics andesites and tuffs. Sonoma Volcanics and the older Mesozoic Great Valley sequence are exposed in a structural uplift area in the small hills in the Yountville area.

Further north, a Sonoma Volcanics andesite flow breccia appears to transition into a sedimentary conglomerate along the center of the valley. This unit is encountered in deep, high yielding wells also completed in the overlying alluvium fluvial facies, but it is not clear if this unit also is high yielding. Overlying the conglomerate/breccia on the east is the sedimentary Huichica Formation of sandstones and mudstones (?). To the west of the unit occur older Sonoma Volcanics andesites, tuffs in the south, and younger (?) Sonoma Volcanics tuffs interbedded with Huichica Formation (?) sedimentary deposits of sand and gravels and clays. All of the Tertiary

[1] Occurrence of strata in contact with the undersurface of a stratigraphic unit, which in this case includes the strata beneath the alluvium.

units beneath the Napa Valley Floor appear to be low to moderately water yielding with poor aquifer characteristics.

Linking Well Construction Information to Groundwater Monitoring Data

As part of the updated hydrogeologic characterization, existing monitoring well construction data from all available public sources were reviewed to determine the distribution of aquifer-specific monitoring data in Napa Valley. This effort addresses recommendations of the Comprehensive Groundwater Management Program to identify and fill data gaps that will allow for analysis of groundwater occurrence and flow as a more robust understanding of the extent of groundwater resources in the county is developed. A major component of this work has been to identify construction information for previously monitored wells in Napa Valley.

Groundwater level monitoring needs identified through the Comprehensive Groundwater Management Program include improved spatial distribution of groundwater level monitoring, additional characterization of subsurface geologic conditions in county subareas to identify aquifer characteristics, further examination of well construction information to define which portion of the aquifer system is represented by water levels measured in the currently monitored wells (and in many cases to link construction information to the monitored wells), and improve the understanding of surface water/groundwater interactions and relationships.

To address these needs, the Data Management System (DMS) created as part of the Comprehensive Groundwater Management Program was used along with a set of over 6,000 well drillers' reports for wells drilled in the county through 2011. Location and other data about wells where water level data have been collected within the Napa Valley Floor were extracted from the Napa DMS by a query that returned 938 wells. Four hundred sixty-eight of those are wells constructed for monitoring regulated soil and groundwater contamination sites. Of the remaining 470 wells, nine have a record of destruction or abandonment in the DMS. Many more of the 470 non-regulated monitoring wells are likely duplicate entries accumulated in the DMS as a result of records compiled from multiple monitoring entities.

Well construction information for these wells was identified by comparing data about the wells available in the Napa DMS with the actual drillers' reports that contain the well driller's record of subsurface lithology encountered during the drilling process. Information in the Napa DMS was compared in sequence for each well and included the township/range/section, parcel number, well address, type of well, intended use, and date of well completion. The range of data collected at each well relative to the recorded well completion date on the Well Completion Report was also referenced as a secondary indicator when more than one well was found with a given address or parcel. Records compiled by Kunkel and Upson (1960), who performed an extensive survey of wells drilled in Napa Valley through approximately 1952, were also referenced in cases where the earliest measurements or date of well completion were prior to 1960, which predates most drillers' reports from Napa County that were provided by DWR. Due to slight variations in location information recorded by various monitoring entities over time, multiple point locations have sometimes been assigned for a single well. The Napa DMS and direct communications with Napa County staff were used to identify duplicate well records. The DMS was used to compare metadata, including well depth, borehole depth, and construction date to avoid over representation of sites where water levels have been or are being recorded.

This process identified 42 duplicate well entries for sites where water levels have been or are currently monitored by Napa County, DWR, and USGS.

Monitored wells with at least 5 years of monitoring data and that are also relatively close to the mainstem Napa River were identified to address the need for improved monitoring of groundwater/surface water interactions in Napa Valley. That process identified 101 wells located within a one-quarter mile radius of the Napa River, with 38 wells which were not associated with regulated soil and groundwater contamination sites. A total of 180 wells were found within a one-half mile radius of the Napa River, with 89 of those not associated with regulated sites. Although the regulated sites most often have aquifer-specific shallow monitoring wells completed in the alluvial aquifer system, their spatial distribution is skewed to coincide with the developed population centers in the valley.

All monitored wells with at least 5 years of data were then compared by location with existing surface water gauges along the Napa River to evaluate the potential for pairing measurements of river stage with groundwater levels to assess surface water/groundwater interactions. Ultimately, six sites spanning from the City of Napa north to St. Helena were identified for future monitoring focus (see additional discussion of these sites in Section 4).

Groundwater Recharge Characterization and Estimates

Another important feature of the current hydrogeologic investigation is the development of improved characterization of groundwater recharge in the areas of greatest groundwater development, with an emphasis on Napa Valley. Understanding the volume of and mechanisms driving groundwater recharge in the county will be essential in determining where and how much groundwater can be produced without incurring negative impacts (LSCE, 2011a). Currently, evaluation of recharge mechanisms and volumes within Napa County has been limited to the Napa Valley (Faye, 1973) and the MST Subarea (Johnson, 1977; Farrar and Metzger, 2003).

The high permeability of the alluvial sediments in the Napa Valley permits precipitation and surface water to readily infiltrate and recharge groundwater throughout the majority of the valley. These high permeability soils combined with the large volume of water that flows through the Napa River create the potential for significant recharge to occur under the hydrologic circumstances and hydraulic gradient that allow for recharge from the river to groundwater to occur.

For the current project, mass balance and streamflow infiltration methods are being used to estimate regional and local recharge. Streamflow infiltration can be characterized by comparing the elevation of surface water to the shallowest adjacent groundwater. Detailed remotely sensed elevation data of the mainstem Napa River and several major tributaries have been obtained for this purpose. These LiDAR data provide sub-meter precision elevation data and have been sampled at 3 foot intervals along each watercourse. These data are paired with previously collected groundwater level data and estimates of areas of greatest recharge potential to estimate the potential for recharge to groundwater.

In addition, mass balance recharge estimates have been developed for the Napa River watershed and major tributary watersheds using a range of available data (LSCE and MBK Engineers, 2013 in progress). Available records for streamflow, precipitation, land use, and vegetative cover throughout these watersheds have been used to develop spatially-distributed estimates of annual

hydrologic inputs and outputs in order to solve for the volume of groundwater recharge. Key components of this work include quantifying the distribution of precipitation across the land surface, quantifying the amount of water that returns to the atmosphere by evapotranspiration, and quantifying the hydraulic properties of soil and alluvial materials through which water must infiltrate to reach groundwater. Estimates developed through the mass balance approach have been evaluated using a sensitivity analysis to determine the degree to which any individual or set of inputs affects the recharge estimate.

2.3.4 Groundwater Monitoring Priorities

Priorities for addressing groundwater level and quality monitoring are presented below. These are based on the analysis of existing groundwater data and conditions described in the Groundwater Report (LSCE, 2011a). Preliminary prioritizations presented in the Groundwater Report are provided in Appendix A. The recommendations from the Groundwater Report have been slightly updated with input received from the GRAC.

Groundwater Level Monitoring

Currently, groundwater level measurements are recorded at a total of 87 sites (measurements began in 1920 for one Napa County monitoring well that is still being monitored). **Table 2-2** and **Figure 2-4** summarize the currently conducted monitoring in each subarea. Also shown in **Table 2-2** are the preliminary ranking and priorities for improving or expanding groundwater level monitoring in each of the designated subareas. Six subareas (including the NVF-Calistoga, NVF-MST, NVF-Napa, NVF-St. Helena, NVF-Yountville, and Carneros Subareas) are given a relatively higher priority. This relative prioritization is based on such factors as data scarcity, the need to improve the spatial distribution of the currently collected data, current population and groundwater utilization relative to other parts of the county, and /or the need to improve understanding of groundwater/surface water interactions. Some factors are given greater consideration in areas that currently use more groundwater than other areas. In mountainous areas where less groundwater development has occurred, where geologic conditions are complicated by basement rocks that are complexly deformed by folding and faulting and are well lithified, and overall there is considerable variability (LSCE, 2011a), future monitoring needs could be considered in coordination with potential or planned development in localized areas. Overall, groundwater level monitoring priorities are to identify seasonal and long-term trends and develop the data that facilitate better understanding of groundwater conditions, including response to such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage.

Groundwater level monitoring needs include improved spatial distribution of groundwater level monitoring, additional characterization of subsurface geologic conditions in each subarea to identify aquifer characteristics, further examination of well construction information to define which portion of the aquifer system is represented by water levels measured in the currently monitored wells, and improve the understanding of surface water – groundwater relationships.

Table 2-2
Groundwater Level Monitoring Sites, Napa County
(Current[1] and Future)

Subarea	No. Sites with Current Groundwater Level Data	Future Groundwater Level Monitoring		Monitoring Needs
		Relative Priority	Action (Expand/ Refine)	
Napa Valley Floor-Calistoga	**6**	**H**	E	**SP, SW**
Napa Valley Floor-MST	**29**	**H**	R	**SP, SW**
Napa Valley Floor-Napa	**18**	**H**	R	**SP, SW**
Napa Valley Floor-St. Helena	**12**	**H**	E	**SP, SW**
Napa Valley Floor-Yountville	**9**	**H**	E	**SP, SW**
Carneros	**5**	**H**	E	**B**
Jameson/American Canyon	1	M	E	B
Napa River Marshes	1	M	E	SP, SW
Angwin	0	M	E	B
Berryessa	3	L	E	B
Central Interior Valleys	1	L	E	B
Eastern Mountains	0	L	E	B
Knoxville	1	L	E	B
Livermore Ranch	0	L	E	B
Pope Valley[2]	1	L	E	B
Southern Interior Valleys	0	L	E	B
Western Mountains	0	L	E	B
Total	**87**			

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2011 or later. “Future” refers to recommended monitoring locations.
[2] The relative priority for Pope Valley was changed from “high” in the Groundwater Report to “low” in the Plan based on input from the GRAC on the current population and groundwater use in this subarea.

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells coordinated with recent geologic investigations that are or will be conducted)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs:
SP = Improve horizontal and/or vertical spatial distribution of data, including for the purpose of identifying such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage;
SW =identify appropriate monitoring site to evaluate surface water -groundwater recharge/discharge mechanisms;
B = Basic data needed to accomplish groundwater level monitoring objectives

Groundwater Quality Monitoring

The current groundwater quality monitoring network consists of 177 monitoring sites (**Table 2-3 and Figure 2-5**). Of these sites, some of the wells, but not all, have well construction information. Current groundwater quality monitoring sites are fairly well distributed throughout the Napa Valley Floor Subarea but are generally sparse elsewhere in the county. Recommended improvements to the groundwater quality monitoring program, and priority timelines for improvements, are summarized in **Table 2-3** and discussed further in the Groundwater Report (LSCE, 2011a).

Table 2-3 includes a ranking and prioritization for improving or expanding groundwater quality monitoring in each of the designated subareas. Three subareas (including NVF-MST, Carneros, and Jameson/American Canyon Subareas) are given a relatively higher priority. This relative prioritization is based on such factors as data scarcity, the need to improve the spatial distribution of the currently collected data, current population and groundwater utilization relative to other parts of the county, and/or the need to improve understanding of groundwater/surface water interactions. Some factors are given greater consideration in areas that currently use more groundwater than other areas. Seven subareas, including Berryessa, Central Interior Valleys, Knoxville, Livermore Ranch, Pope Valley, Southern Interior Valleys, and Western Mountains, are assigned lower priorities for groundwater quality monitoring due to the likely lower levels of projected land and groundwater use. The seven remaining subareas are designated as medium priorities for groundwater quality monitoring. Many of these areas have current monitoring programs, so the emphasis in these areas is to further examine land use with respect to monitoring locations and the units(s) of the aquifer system represented by this monitoring. For example, the Eastern Mountains Subarea appears to include 25 current groundwater quality monitoring sites. However, the source of this data is largely GeoTracker GAMA, which includes California Department of Public Health (DPH) data for community water supply wells. Consequently, these wells are assigned imprecise locations by DPH such that the well locations are accurate to plus or minus one mile. Most likely, these wells are actually located in the main Napa Valley Floor.

Table 2-3 also includes key factors related to monitoring needs. Many subareas outside the Napa Valley Floor have limited spatial distribution of the current groundwater quality monitoring wells/sites. Basic data are described as a key need to accomplish the Plan's groundwater quality monitoring objectives. Importantly, expansion and/or refinement of groundwater quality monitoring conducted in all subareas should be coordinated with efforts to expand or refine groundwater level monitoring to be able to relate water quality trends to constituent transport within the aquifer system.

Table 2-3
Groundwater Quality Monitoring Sites, Napa County
(Current[1] and Future)

Subarea	No. Sites with Current Groundwater Quality Data	Future Groundwater Quality Monitoring		Monitoring Needs
		Relative Priority	Action (Expand/ Refine)	
Napa Valley Floor-Calistoga	20	M	R	SP,C
Napa Valley Floor-MST	**16**	**H**	R	**SP,C**
Napa Valley Floor-Napa	21	M	R	SP,C
Napa Valley Floor-St. Helena	31	M	R	SP,C
Napa Valley Floor-Yountville	14	M	R	SP,C
Carneros	**9**	**H**	R	**SP,C**
Jameson/American Canyon	**3**	**H**	E	**B,SP,C**
Napa River Marshes	6	M	E	B,SP,C
Angwin	4	M	E	B,C
Berryessa	6	L	E	B,C
Central Interior Valleys	6	L	R	B,SP,C
Eastern Mountains	25	M	E/R	B,C
Knoxville	0	L	E	B,C
Livermore Ranch	0	L	E	B,C
Pope Valley[2]	6	L	E	B,C
Southern Interior Valleys	1	L	E	B,C
Western Mountains	10	L	R	B,C
Total	**177**			

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2008 or later. “Future” refers to recommended monitoring locations.
[2] The relative priority for Pope Valley was changed from “high” in the Groundwater Report to “low” in the Plan based on input from the GRAC on the current population and groundwater use in this subarea. Similarly, some subareas previously in a “medium” category were changed to a relatively low ranking.

L = Low Priority; add groundwater quality and also level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater quality and also level monitoring

H = High Priority; add groundwater quality and also level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information and as the well may be available for monitoring; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells (coordinate with potential geologic investigations that may be conducted in selected areas)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs: SP = Improve horizontal and/or vertical spatial distribution of data; B = Basic data needed to accomplish groundwater level monitoring objectives; C = Coordinate with groundwater level monitoring

Note: Some sites with current groundwater quality data are approximately located and currently may not be counted in the correct subarea. Also, additional sites with current groundwater quality beyond this tabulation exist but the locations are currently unavailable and unable to be counted at this time.

2.3.5 Recommendations from Recent County Studies

Groundwater Level Monitoring Recommendations from the Groundwater Report

Below are recommendations from the 2011 Groundwater Report (LSCE, 2011a) in order to implement the expansion and improvement of countywide groundwater level monitoring activities by the County and others.

1. Replace water level monitoring wells that are completed in more than one aquifer with wells completed in (or representative of) a single aquifer (a phased approach is recommended for this effort that considers the historical record for existing wells in the network).
2. Continue groundwater level monitoring on at least a semi-annual basis; increase the spatial and vertical distribution of wells for monthly water level measurements (e.g., in key areas) to allow more comprehensive evaluation of groundwater conditions and stream-aquifer relationships.
3. Perform GPS surveys with higher accuracy instrumentation, as may be needed, to establish updated reference point elevation data.
4. Communicate County groundwater level monitoring objectives to private and commercial landowners and invite voluntary participation in the ongoing program (i.e., access to suitable wells with construction information located in areas of interest to meet subarea-specific monitoring objectives).

Groundwater Quality Monitoring Recommendations from the Groundwater Report

Below are recommendations from the 2011 Groundwater Report (LSCE, 2011a) in order to implement the expansion and improvement of countywide groundwater quality monitoring activities.

1. Implement efforts to expand and/or refine the groundwater quality monitoring program such that more wells can be “qualified” with well construction information.
2. Review the historically monitored wells to determine whether some of these may be suited to the objectives of gathering basic data and/or expanding groundwater quality monitoring in the various county subareas.
3. Coordinate expansion of the groundwater quality monitoring program with the expansion/refinement of subarea groundwater level monitoring.
4. Communicate County groundwater quality monitoring objectives to private and commercial landowners and invite voluntary participation in the ongoing program (i.e., access to suitable wells with construction information located in areas of interest to meet subarea-specific monitoring objectives).
5. As feasible, replace monitoring wells that are completed in more than one zone or aquifer with wells completed in a single unit that meets regional and subarea-specific groundwater quality monitoring objectives.

Summary of Overall Groundwater Monitoring Program Recommendations from the 2011 Groundwater Report

1. County establish its role as lead agency for ongoing groundwater monitoring program coordination and database oversight and management.
2. Establish plan for pertinent County departments to coordinate data collection, storage, and analysis efforts.
3. Identify potential collaborators (including local, federal, and state agency representatives) and interested stakeholders for the ongoing program.
4. Annually update the DMS (e.g., groundwater levels and quality and other water-related data), assess network and findings, and make changes to the program where necessary.
5. Discuss monitoring parameters of special interest with collaborators.
6. Review groundwater data annually and revise or make recommendations to revise data collection accordingly, pending changes to network wells and/or specific program objectives.
7. Identify locations for construction of dedicated monitoring wells for water level and/or quality monitoring (e.g., county subareas where more subsurface information is required to better quantify groundwater availability and quality, recharge areas where aquifer-specific monitoring is lacking, surface water-groundwater interaction, etc.).
8. Replace (over time) wells in the monitoring network that have no well construction information (or are perforated in more than one zone) to improve the understanding of aquifer-specific conditions.
9. Coordinate efforts being conducted for water supply investigation work (e.g., test hole construction) with opportunities for constructing zone-specific dedicated monitoring facilities for countywide water level and/or water quality monitoring.
10. Communicate program results to cooperating entities.
11. Provide an overview of program objectives, benefits and results to the general public via web information and other communication vehicles.
12. Seek funding to support program continuation, including DMS, data evaluation, and implementation of priority recommendations.
13. Explore the need to develop guidelines for testing private wells to evaluate potential water quality issues.

Napa County CASGEM Plan Recommendations

The County's 2011 CASGEM program (LSCE, 2011b) reported that the County plans to include at least one additional monitoring well in the Pope Valley and Berryessa Valley Groundwater Basins as well as additional wells in other subareas (including the NVF-Calistoga, NVF-MST, NVF-Napa, NVF-St. Helena, NVF-Yountville, and Carneros Subareas) over the coming years. Additional wells in these subareas are of interest for (LSCE, 2011a):

- Improving horizontal and/or vertical spatial distribution of data;
- Identifying appropriate monitoring sites to evaluate surface water-groundwater interaction; and

- Establishing additional basic data needed to accomplish groundwater level monitoring objectives.

Summary of Recommendations

Groundwater Level Monitoring

Per the priorities discussed in this section, additional groundwater level monitoring wells are recommended in the following subareas:

- NVF-MST
- NVF-Napa
- NVF-St. Helena
- NVF-Yountville
- NVF-Calistoga
- Carneros
- Pope Valley (CASGEM)
- Berryessa Valley (CASGEM)

Additional monitoring in the subareas in the Napa Valley Floor would be especially to improve the horizontal and spatial distribution of groundwater level data to better understand groundwater conditions, including response to such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage.

Additional groundwater level monitoring is needed to further evaluate surface water-groundwater interaction and recharge/discharge mechanisms. It is especially recommended that dedicated shallow monitoring wells be constructed at appropriate locations, particularly along the main stem of the Napa River, for this purpose.

Groundwater Quality Monitoring

Per the priorities discussed in this section, additional groundwater quality monitoring wells are recommended in the following subareas:

- NVF-MST
- Carneros
- Jameson/American Canyon

Additional wells in these subareas are to improve horizontal and/or vertical spatial distribution of data and also to establish baseline groundwater quality conditions. Groundwater level monitoring would also occur at any wells added for groundwater quality monitoring in order to evaluate trends in and/or movement of the monitored constituents.

Further examination of the suitability of existing wells for groundwater monitoring (including their location and construction and relevance to meet County and/or CASGEM monitoring objectives) is necessary to determine if any existing wells would be suitable for ongoing evaluation of groundwater conditions. If existing private wells are considered, approval from the property owners to voluntarily participate in the County's groundwater monitoring program would be sought. Additional wells may be added to provide better spatial and/or vertical

distribution of monitored locations within the subareas and to enhance the understanding of localized groundwater conditions and availability.

Section 4 outlines steps to optimize additional groundwater monitoring locations that serve to meet the objectives of the County's Comprehensive Groundwater Monitoring Program and the CASGEM monitoring program.

3 GROUNDWATER RESOURCES GOALS AND MONITORING OBJECTIVES

3.1 Napa County Water Resources Goals and Policies

The County's General Plan (2008, amended June 23, 2009) recognizes, "water is one of the most complex issues related to land use planning, development, and conservation; it is governed and affected by hundreds of federal, state, regional, and local mandates pertaining to pollution, land use, mineral resources, flood protection, soil erosion, reclamation, etc. Every year, the state legislature considers hundreds of bills relating to water issues, and in Napa County, more than two dozen agencies have some say in decisions and regulations affecting water quality and water use."

As part of the General Plan update in 2008, and within the Conservation Element, six goals are set forth relating to the County's water resources, including surface water and groundwater. Complementing these goals are twenty-eight policies and ten water resources action items (one of which is "reserved" for later description). The County's six water resources goals are included below (the entire group of water resources goals, policies, and action items is included in LSCE, 2011a).

> **Goal CON-8:** Reduce or eliminate groundwater and surface water contamination from known sources (e.g., underground tanks, chemical spills, landfills, livestock grazing, and other dispersed sources such as septic systems).
>
> **Goal CON-9:** Control urban and rural storm water runoff and related non-point source pollutants, reducing to acceptable levels pollutant discharges from land-based activities throughout the county.
>
> **Goal CON-10:** Conserve, enhance and manage water resources on a sustainable basis to attempt to ensure that sufficient amounts of water will be available for the uses allowed by this General Plan, for the natural environment, and for future generations.
>
> **Goal CON-11:** Prioritize the use of available groundwater for agricultural and rural residential uses rather than for urbanized areas and ensure that land use decisions recognize the long-term availability and value of water resources in Napa County.
>
> **Goal CON-12:** Proactively collect information about the status of the County's surface and groundwater resources to provide for improved forecasting of future supplies and effective management of the resources in each of the County's watersheds.
>
> **Goal CON-13:** Promote the development of additional water resources to improve water supply reliability and sustainability in Napa County, including imported water supplies and recycled water projects.

Addressing the six water resources goals above, the County has produced specific General Plan Action Items related to the focus and objective of this Plan. Those action items include:

Action Item CON WR-1: Develop basin-level watershed management plans for each of the three major watersheds in Napa County (Napa River, Putah Creek, and Suisun Creek). Support each basin-level plan with focused sub-basin (drainage-level) or evaluation area-level implementation strategies, specifically adapted and scaled to address identified water resource problems and restoration opportunities. Plan development and implementation shall utilize a flexible watershed approach to manage surface water and groundwater quality and quantity. The watershed planning process should be an iterative, holistic, and collaborative approach, identifying specific drainage areas or watersheds, eliciting stakeholder involvement, and developing management actions supported by sound science that can be effectively implemented. [Implements Policies 42 and 44]

Action Item CON WR-4: Implement a countywide watershed monitoring program to assess the health of the County's watersheds and track the effectiveness of management activities and related restoration efforts. Information from the monitoring program should be used to inform the development of basin-level watershed management plans as well as focused sub-basin (drainage-level) implementation strategies intended to address targeted water resource problems and facilitate restoration opportunities. Over time, the monitoring data will be used to develop overall watershed health indicators and as a basis of employing adaptive watershed management planning. [Implements Policies 42, 44, 47, 49, 63, and 64]

Action Item CON WR-6: Establish and disseminate standards for well pump testing and reporting and include as a condition of discretionary projects that well owners provide to the County upon request information regarding the locations, depths, yields, drilling and well construction logs, soil data, water levels and general mineral quality of any new wells. [Implements Policy 52 and 55]

Action Item CON WR-7: The County, in cooperation with local municipalities and districts, shall perform surface water and groundwater resources studies and analyses and work toward the development and implementation of an integrated water resources management plan (IRWMP) that covers the entirety of Napa County and addresses local and state water resource goals, including the identification of surface water protection and restoration projects, establishment of countywide groundwater management objectives and programs for the purpose of meeting those objectives, funding, and implementation. [Implements Policy 42, 44, 61 and 63]

Action Item CON WR-8: The County shall monitor groundwater and interrelated surface water resources, using County-owned monitoring wells and stream and precipitation gauges, data obtained from private property owners on a voluntary basis, data obtained via conditions of approval associated with discretionary projects, data from the State Department of Water Resources, other agencies and organizations. Monitoring data shall be used to determine baseline water quality conditions, track groundwater levels, and identify where problems may exist. Where there is a demonstrated need for additional management actions to address groundwater problems, the County shall work collaboratively with property owners and other stakeholders to prepare a plan for managing groundwater supplies pursuant to State Water Code Sections 10750-10755.4 or other applicable legal authorities. [Implements Policy 57, 63 and 64]

Action Item CON WR-9.5: The County shall work with the SWRCB, DWR, DPH, CalEPA, and applicable County and City agencies to seek and secure funding sources for the County to develop and expand its groundwater monitoring and assessment and undertake community-based planning efforts aimed at developing necessary management programs and enhancements.

3.2 Overarching Groundwater Monitoring Objectives

The following Plan subsections describe a number of water level and quality objectives to be accomplished with the current and refined countywide groundwater level and quality monitoring program. The overarching groundwater monitoring objectives are linked to the County's General Plan goals and action items presented above and also to hydrogeologic conditions and issues of interest, including (but not limited to):

- Monitoring trends in groundwater levels and storage (e.g., groundwater balance) to assess and ensure long-term groundwater availability and reliability;
- Monitoring of groundwater-surface water interactions to ensure sufficient amounts of water are available to the natural environment and for future generations;
- Monitoring in significant recharge areas to assess factors (natural and human-influenced) that may affect groundwater recharge (including climate change) and also aid the identification of opportunities to enhance groundwater recharge and storage;
- Monitoring to establish baseline conditions in areas of potential saline water intrusion;
- Monitoring of general water quality to establish baseline conditions, trends, and protect and preserve water quality.
- Identify where data gaps occur in the key subareas and provide infill, replacement, and/or project-specific monitoring (e.g., such as may occur for planned projects or expansion of existing projects) as needed; and
- Coordinate with other entities on the collection, utilization, and incorporation of groundwater level data in the countywide DMS.

3.2.1 Groundwater Level Monitoring Objectives

The focus of the countywide groundwater level monitoring program includes the following objectives:

- Expand groundwater level monitoring in priority County subareas to improve the understanding of the occurrence and movement of groundwater; monitor local and regional groundwater levels including seasonal and long-term trends; and identify vertical hydraulic head differences in the aquifer system and aquifer-specific groundwater conditions, especially in areas where short- and long-term development of groundwater resources are planned (this includes additional monitoring of the Tertiary formation aquifer in the area between the NVF-MST Subarea and the northeastern part of the NVF-Napa Subarea to determine whether groundwater water conditions in the NVF-MST are affecting other areas (see Section 9 in LSCE and MBK Engineers, 2013 in progress));

- Detect the occurrence of, and factors attributable to, natural (e.g., direct infiltration of precipitation, surface water seepage to groundwater, groundwater discharge to

streams) or induced factors (e.g., pumping, purposeful recharge operations) that affect groundwater levels and trends;

- Identify appropriate monitoring sites to further evaluate surface water-groundwater interaction and recharge/discharge mechanisms, including whether groundwater utilization is affecting surface water flows;

- Establish a monitoring network to aid in the assessment of changes in groundwater storage; and

Generate data to better estimate groundwater basin conditions and assess local current and future water supply availability and reliability; update analyses as additional data become available.

Based on the analysis of existing groundwater data and conditions described in the Groundwater Report (LSCE, 2011a) and with input received from the GRAC, the key objectives for future groundwater level monitoring for each subarea are summarized in Appendix A.

3.2.2 Groundwater Quality Monitoring Objectives

The primary objectives of the countywide groundwater quality monitoring program include:

- Evaluate groundwater quality conditions in the various county subareas and identify differences in water quality spatially between areas and vertically in the aquifer system within a subarea;

- Detect the occurrence of and factors attributable to natural (e.g., general minerals and trace metals) or other constituents of concern;

- Establish baseline conditions in areas of potential saltwater intrusion, including the extent and natural occurrence and/or causes of saltwater beneath the Carneros, Jameson/American Canyon and Napa River Marshes Subareas;

- Assess the changes and trends in groundwater quality; and

- Identify the natural and human factors that affect changes in water quality.

Based on the analysis of existing groundwater data and conditions described in the Groundwater Report (LSCE, 2011a) and with input received from the GRAC, the key objectives for future groundwater quality monitoring for each subarea are summarized in Appendix A.

3.3 Collaboration and Funding for Groundwater Monitoring

As described above, the County wishes to promote interagency collaboration and coordination on the collection, utilization, and incorporation of groundwater monitoring data into the DMS and to achieve countywide groundwater resources goals and monitoring objectives. As also noted above, the County has an existing Action Item (CON WR-9.5) that sets forth its interest in

working with the SWRCB, DWR, DPH, CalEPA, and applicable County and City agencies to seek and secure funding sources for the County to develop and expand its groundwater monitoring and assessment, and undertake community-based planning efforts aimed at developing necessary management programs and enhancements.

The Groundwater Management Act adopted in 2002 (SB 1938) amended and expanded AB 3030 groundwater management plans. As discussed in the technical memorandum prepared for the County on *Groundwater Planning Considerations and Review of Napa County Groundwater Ordinance and Permit Process* (LSCE, 2011), the California Water Code requires public agencies seeking priority for state funds administered through DWR (e.g., Local Groundwater Assistance (LGA) grant program) for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan with certain required components (Water Code Section 10753.7). Previously, all plans were voluntary, and there were no required plan components. The requirements now include establishing basin management objectives, preparing a plan to involve other local agencies in the basin in a cooperative planning effort, and more comprehensive monitoring programs (including groundwater levels and quality; surface water flows and quality; and inelastic land surface subsidence for basins where it is identified as a potential concern) to assess changes in basin conditions and "generate information that promotes efficient and effective groundwater management" (Water Code Section 10753.7).

As described above, on November 6, 2009, SBx7-6 (e.g., the CASGEM program) was enacted. This revised Water Code Section 10920 et seq. and established a groundwater monitoring program designed to monitor and report groundwater elevations in all or part of a basin or subbasin. These new requirements also limit counties and various entities' (Water Code Section 10927.(a)-(d), inclusive) ability to receive state grants or loans in the event that DWR is required to perform groundwater monitoring functions pursuant to Water Code 10933.7 (DWR, 2012). The goal of the LGA grant program is to improve groundwater resource management and the knowledge of various groundwater basins throughout the state by funding projects that will provide long-term benefit to the management of groundwater (DWR, 2012). A comprehensive groundwater monitoring program is an integral part of this goal. As such, this Plan would greatly improve the County's ability to apply for state and possibly federal funds in the future.

4 GROUNDWATER MONITORING NETWORK DESIGN AND DEVELOPMENT

This section describes the existing well monitoring network and well qualification efforts concurrently being conducted to attempt to link well construction information to wells with historical groundwater level and/or groundwater quality monitoring records. This section will also discuss data gaps identified as a result of the well qualification efforts and the monitoring wells needed to achieve the groundwater monitoring objectives described in Section 3. The means by which the monitoring network gaps might be addressed include:

1) Investigating the potential to restart monitoring where historical records are available but monitoring was discontinued;
2) Identification of existing wells of suitable construction that might be volunteered for inclusion through County and GRAC education and outreach efforts; and
3) Construction of new dedicated monitoring wells if suitable existing wells either do not exist in the area of interest or are otherwise not available.

This section includes monitoring protocols to meet program objectives (i.e., including developing a program capable of tracking changes in groundwater level and quality conditions and groundwater/surface water interrelationships). In support of the County's General Plan Goal CON-12 and Action Item CON WR-7 (see Section 3), the monitoring protocols are designed to generate information that promotes efficient and effective groundwater management.

This section also includes recommendations for filling spatial/vertical groundwater monitoring data gaps. Finally, this section includes recommended monitoring frequencies for groundwater levels and quality and recommended groundwater quality monitoring parameters.

4.1 Groundwater Level Monitoring

This section describes existing groundwater level monitoring and recommended locations for wells for groundwater level monitoring to fill data gaps. As additional monitoring facilities are considered, or existing facilities are further evaluated, the objectives provided in **Section 3** will be used evaluate the suitability of the existing or proposed facilities to ensure that the data being (or planned to be) collected can address these objectives.

4.1.1 Monitoring Network

Existing Groundwater Level Monitoring Wells

Figure 4-1 illustrates the distribution of current groundwater level monitoring locations, which is primarily located in the Napa Valley Floor-Napa and MST Subareas. Very little groundwater level monitoring is currently conducted elsewhere in Napa County outside these two subareas. A few scattered locations of groundwater level monitoring occur in the Berryessa, Pope Valley, the southern portion of the Central Interior Valleys, Jameson/American Canyon, and in the NVF-Calistoga, NVF-St. Helena, and NVF-Yountville Subareas. Groundwater level monitoring is not currently conducted in the Carneros, Livermore Ranch, Angwin, Southern Interior Valleys, and Western Mountains Subareas. **Table 4-1** summarizes the number of wells in each subarea that are currently monitored for groundwater levels (a detailed list is included in **Appendix A)**.

Groundwater level measurements have been recorded at a total of 87 sites since 2011. Of these sites where groundwater levels are measured, some type of well construction information (depth and/or perforated interval(s)) is readily available for 67 sites (41 non-regulated sites and 26 regulated sites). Most current groundwater level monitoring occurs on a semi-annual frequency.

Recommendations to Expand Monitoring Well Network

As presented above in **Table 2-2**, and summarized in Section 2, a preliminary ranking and priorities for improving or expanding groundwater level monitoring were prepared for each county subarea. Six subareas are given a relatively higher priority for improving the groundwater level monitoring network based on factors of current population and groundwater utilization relative to other parts of the county, and/or the need to improve understanding of groundwater/surface water interactions. Some factors are given greater consideration in areas that currently use more groundwater than other areas. These areas include:

- NVF-Calistoga,
- NVF-St. Helena,
- NVF-Yountville,
- NVF- MST,
- NVF-Napa, and
- Carneros Subareas

The monitoring network gaps in these six subareas might be addressed by:

1) Investigating the potential to restart monitoring where historical records are available but monitoring was discontinued;
2) Identifying existing wells of suitable construction that might be volunteered for inclusion through County and GRAC education and outreach efforts (this may include wells that are already being monitored for groundwater quality); and
3) Constructing new dedicated monitoring wells if suitable existing wells either do not exist in the area of interest or are otherwise not available.

Monitoring in other subareas with relatively medium to lower priorities is suggested to be addressed with volunteered wells.

The Napa County CASGEM Network Plan submitted to DWR in September 2011 (LSCE, 2011) also describes the County's intent to include at least one additional monitoring well in the Pope Valley and Berryessa Valley Groundwater Basins, as noted above.

The County will conduct additional public outreach to inform more private well owners of the value of understanding the groundwater resources in the County and to encourage their voluntary participation in the Comprehensive Groundwater Monitoring Program and/or CASGEM program. The County anticipates additional wells to be included in the CASGEM program over the coming years. Wells will be included based upon input from the County's GRAC and in concert with their work to meet the objectives of the County's Comprehensive Groundwater Monitoring Program and the CASGEM program.

For each county subarea, **Table 4-1** shows the existing monitoring sites, provides recommendations for the number and location of additional monitoring areas, and describes the key groundwater level monitoring objectives to be addressed. Altogether, it is recommended that approximately six groundwater/surface water monitoring sites for purposes of evaluating groundwater/surface water interactions and about 18 other areas of interest (AOIs) be added to the network (**Figure 4-1**).

Table 4-1
Groundwater Level Monitoring Sites, Napa County
(Current[1] and Recommended Additional Sites)

Subarea	No. Sites with Current Ground-water Level Data	Future GW Level Monitoring (Relative Priority)		Monitoring Needs	Recommend Addn'l Sites[2] (Number of Areas of Interest; Additional Volunteered Sites)	Proposed Areas of Interest for Monitoring	Key Monitoring Objectives[3]
Napa Valley Floor-Calistoga	**6**	**H**	**E**	**SP, SW**	**2 AOIs; V**	**14, 15**	**Conditions, Trends, Wtr Budget, SW**
Napa Valley Floor-MST	**29**	**H**	**R**	**SP, SW**	**V**		**Conditions, Trends, Wtr Budget, SW**
Napa Valley Floor-Napa	**18**	**H**	**R**	**SP, SW**	**2 SW; 4 AOIs; V**	**5, 6, 7, 8**	**Conditions, Trends, Wtr Budget, SW**
Napa Valley Floor-St. Helena[4]	**12**	**H**	**E**	**SP, SW**	**2 SW; 3AOIs; V**	**11, 12, 13**	**Conditions, Trends, Wtr Budget, SW**
Napa Valley Floor-Yountville	**9**	**H**	**E**	**SP, SW**	**2 SW; 2 AOIs; V**	**9, 10**	**Conditions, Trends, Wtr Budget, SW**
Carneros	**5**	**H**	**E**	**B**	**1 AOI; V**	**4**	**Conditions, Trends, Wtr Budget, Saltwater**
Jameson/American Canyon	1	M	E	B	3 AOIs; V	1, 18	Conditions, Trends, Wtr Budget, Saltwater
Napa River Marshes	1	M	E	SP, SW	1 AOI; V	2, 3	Conditions, Trends, Wtr Budget, Saltwater
Angwin	0	M	E	B	1 AOI; V	16	Conditions, Trends, Wtr Budget
Berryessa	3	L	E	B	V		Conditions, Trends (includ. CASGEM)
Central Interior Valleys	1	L	E	B	V		Conditions, Trends
Eastern Mountains	0	L	E	B	V		Conditions, Trends
Knoxville	1	L	E	B	V		Conditions, Trends
Livermore Ranch	0	L	E	B	V		Conditions, Trends
Pope Valley	1	L	E	B	1 AOI; V	17	Conditions, Trends (includ. CASGEM)
Southern Interior Valleys	0	L	E	B	V		Conditions, Trends
Western Mountains	0	L	E	B	V		Conditions, Trends
Total	**87**				**6 SW; 18 AOIs; V**		

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2011 or later. "Future" refers to recommended monitoring locations.
[2] The numbers shown in this column refer to the number of areas of interest for additional monitoring. SW in this column refers to recommended sites for groundwater/surface water monitoring. "V" refers to additional water

supply wells (private or other) that may be volunteered for participation in the County program. "AOI" refers to the Area of Interest for monitoring; see Figure 4-1 for AOI locations.
[3] The Groundwater Level Monitoring Objectives shown in this column are "shorthand" descriptors for the objectives explained in Section 3.
[4] The wells shown in the Recommended Additional Sites column include one or more of the City of St. Helena's wells.

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information and as the well may be available for monitoring; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells (coordinate with potential geologic investigations that may be conducted in selected areas)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs: SP = Improve horizontal and/or vertical spatial distribution of data; SW =identify appropriate monitoring site to evaluate surface water -groundwater interrelationships; B = Basic data needed to accomplish groundwater level monitoring objectives

The six proposed groundwater monitoring sites are located along the main Napa Valley Floor from the City of Napa north to St. Helena adjacent to the Napa River system (**Figure 4-1**). These facilities are planned to be located near to existing stream gauging stations and/or near areas where stream monitoring can also be conducted. The proposed groundwater monitoring facilities are also being sited, where possible, adjacent to existing groundwater monitoring facilities (i.e., typically water supply wells constructed to greater depths in the aquifer system). The proposed monitoring wells will enable focused data collection regarding groundwater elevations and water quality to identify and characterize interactions with surface water.

Frequency of Monitoring

Historically, the County has measured the newly designated CASGEM wells semi-annually in the spring (April) and fall (October) of each year. Historical hydrographs show that these measurement periods generally correspond to the seasonal high and low groundwater elevations observed in their respective county subareas. The County will continue to measure the CASGEM wells semi-annually during similar periods.

Monthly water level monitoring is limited and does not currently provide adequate data to evaluate the effects of hydrologic events or stresses on the aquifer system. In particular, 3 wells are monitored monthly by DWR. These wells are located in the NVF-Calistoga; NVF- St. Helena, and NVF-Napa Subareas, respectively, and are also located generally near the Napa River. It is recommended that selected additional wells (existing and new) be measured monthly to evaluate hydrologic effects and particularly the wells at the six sites recommended to assess surface water and groundwater interrelationships (Napa County, 2012).

Field Methods

Napa County has documented field procedures for the collection of groundwater level measurements which were updated as part of the County's Comprehensive Groundwater Monitoring Program (LSCE, 2010b). These procedures and an example form for recording water level measurements are included in **Appendix C**). The County uses these procedures for the CASGEM program as well as continued monitoring of wells where water level data are submitted to DWR semi-annually for inclusion in DWR's Water Data Library, and the monitoring of other wells measured for County information.

4.2 Groundwater Quality Monitoring

This section describes existing groundwater quality monitoring and recommended locations for wells for groundwater quality monitoring to fill data gaps. As additional monitoring facilities are considered, or existing facilities are further evaluated, the objectives provided in Section 3 will be used to evaluate the suitability of the existing or proposed facilities to ensure that the data being (or planned to be) collected can address these objectives.

4.2.1 Monitoring Network

Existing Groundwater Quality Monitoring Wells

The current groundwater quality monitoring network consists of 177 sites (**Table 4-2; see detailed list in Appendix B**). Current groundwater quality monitoring sites are fairly well distributed throughout the Napa Valley Floor Subarea (**Figure 4-2).** Recommended improvements to the groundwater quality monitoring program, and priority timelines for improvements are discussed below.

Recommendations

As presented above in **Table 2-2**, and summarized in Section 2, a preliminary ranking and priorities for improving or expanding groundwater quality monitoring were prepared for each of the county subareas. Three subareas are given a relatively higher priority for improving the groundwater quality monitoring network based on the lack of spatially distributed groundwater quality monitoring. Although other areas also lack baseline groundwater quality data, these areas are given a relatively higher priority due to interest in better understanding naturally occurring metals (MST) and naturally occurring elevated salinity levels (e.g., Jameson/American Canyon and Napa River Marshes).These areas include:

- NVF-MST;
- Carneros; and
- Jameson/American Canyon Subareas.

Seven subareas, including Berryessa, Central Interior Valleys, Knoxville, Livermore Ranch, Pope Valley, Southern Interior Valleys and Western Mountains, are assigned relatively lower priorities for groundwater quality monitoring due to lower levels of land and groundwater use and/or there appear to be additionally available groundwater quality data from DPH that can be further examined for completeness and ongoing evaluation. The seven remaining subareas are

designated as medium priorities for groundwater quality monitoring. Many of these areas have current monitoring programs, so the emphasis is to periodically examine the groundwater quality data to assess changes in conditions, including any trends in constituent concentrations.

Many subareas outside the Napa Valley Floor have limited spatial distribution of the current groundwater monitoring wells (or monitoring locations). Basic data are described as a key monitoring need and expansion and/or refinement of groundwater monitoring conducted in all subareas should be coordinated with efforts to provide additional characterization of subsurface geologic conditions and well construction information. This effort was undertaken as part of the updated characterization and conceptualization of hydrogeologic conditions for linking groundwater levels to construction data. Over time, it is recommended a similar effort occur for water quality data. Initial efforts to link water quality data to representation of the aquifer system could focus on the MST, Carneros, and Jameson/American Canyon Subareas. This will allow for the evaluation of groundwater conditions specific to an aquifer rather than composite information which limits the ability to fully understand groundwater conditions in the County and in individual subareas.

The monitoring network gaps in the three subareas given a relatively higher priority might be addressed by:

1) Investigating the potential to restart monitoring where historical records are available but monitoring was discontinued;
2) Identifying existing wells of suitable construction that might be volunteered for inclusion through County and GRAC education and outreach efforts; and
3) Constructing new dedicated monitoring wells if suitable existing wells either do not exist in the area of interest or are otherwise not available (this is not likely to be necessary for groundwater quality monitoring purposes only; the six recommended sites with dedicated wells constructed for groundwater level monitoring to evaluate groundwater/surface water interactions could also be added to the groundwater quality monitoring network).

Groundwater quality monitoring is recommended in the 18 AOIs discussed above for groundwater level monitoring. This addresses specific groundwater quality monitoring needs for the relatively higher priority subareas, as well as broader assessment of groundwater quality conditions and trends in other subareas.

Monitoring in other subareas with relatively medium to lower priorities is suggested to be addressed with volunteered wells.

For each county subarea, **Table 4-2** shows the existing monitoring sites, provides recommendations for the number and location of additional monitoring sites, and describes the key groundwater quality monitoring objectives to be addressed.

Table 4-2
Groundwater Quality Monitoring Sites, Napa County
(Current[1] and Recommended Additional Monitoring Sites)

Subarea	No. Sites with Current GW Quality Data	Future GW Quality Monitoring (Relative Priority)		Monitoring Needs	Recommend Addn'l Sites[2] (Number of Areas of Interest; Additional Volunteered Sites)	Proposed Areas of Interest for Monitoring	Key Monitoring Objectives[3]
Napa Valley Floor-Calistoga	20	M	R	SP,C	2 AOIs; V	14, 15	Conditions, Trends, Nat'l Constituents
Napa Valley Floor-MST	**16**	**H**	**R**	**SP,C**	**V**		Conditions Trends, Nat'l Constituents
Napa Valley Floor-Napa	21	M	R	SP,C	2 SW; 4 AOIs; V	5, 6, 7, 8	Conditions, Trends, Nat'l Constituents
Napa Valley Floor-St. Helena	31	M	R	SP,C	2 SW; 3 AOIs; V	11, 12, 13	Conditions, Trends, Nat'l Constituents
Napa Valley Floor-Yountville	14	M	R	SP,C	2 SW; 2 AOIs; V	9, 10	Conditions, Trends, Nat'l Constituents
Carneros	**9**	**H**	**R**	**SP,C**	**1 AOI; V**	**4**	Conditions, Trends, Nat'l Constituents, Saltwater
Jameson/American Canyon	**3**	**H**	**E**	**B,SP,C**	**3 AOIs; V**	**1, 18**	Conditions, Trends, Nat'l Constituents, Saltwater
Napa River Marshes	6	M	E	B,SP,C	1 AOI; V	2, 3	Conditions, Trends, Nat'l Constituents. Saltwater
Angwin	4	M	E	B,C	1 AOI; V	16	Conditions, Trends, Nat'l Constituents
Berryessa	6	L	E	B,C	V		Conditions, Trends, Nat'l Constituents

Subarea	No. Sites with Current GW Quality Data	Future GW Quality Monitoring (Relative Priority)		Monitoring Needs	Recommend Addn'l Sites[2] (Number of Areas of Interest; Additional Volunteered Sites)	Proposed Areas of Interest for Monitoring	Key Monitoring Objectives[3]
Central Interior Valleys	6	L	R	B,SP,C	V		Conditions, Trends, Nat'l Constituents
Eastern Mountains	25	M	E	B,C	V		Conditions, Trends, Nat'l Constituents
Knoxville	0	L	E	B,C	V		Conditions, Trends, Nat'l Constituents
Livermore Ranch	0	L	E	B,C	V		Conditions, Trends, Nat'l Constituents
Pope Valley	6	L	E	B,C	1 AOI; V	17	Conditions, Trends, Nat'l Constituents
Southern Interior Valleys	0	L	E	B,C	V		Conditions, Trends, Nat'l Constituents
Western Mountains	10	L	R	B,C	V		Conditions, Trends, Nat'l Constituents
Total	**177**				**6 SW; 18 AOIs; V**		

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2008 or later. "Future" refers to recommended monitoring locations.
[2]The numbers shown in this column refer to the number of areas of interest for additional monitoring. SW in this column refers to recommended sites for groundwater/surface water monitoring "V" refers to additional water supply wells (private or other) that may be volunteered for participation in the County program (these volunteered wells for groundwater quality monitoring would be coordinated with those volunteered for groundwater level monitoring). "AOI" refers to Areas of Interest for groundwater monitoring; see Figure 4-2 for AOI locations for groundwater quality monitoring.
[3] The Groundwater Level Monitoring Objectives shown in this column are "shorthand" descriptors for the objectives explained in Section 3.

L = Low Priority; add groundwater quality and also level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater quality and also level monitoring

H = High Priority; add groundwater quality and also level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information and as the well may be available for monitoring; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells (coordinate with potential geologic investigations that may be conducted in selected areas)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs: SP = Improve horizontal and/or vertical spatial distribution of data; B = Basic data needed to accomplish groundwater level monitoring objectives; C = Coordinate with groundwater level monitoring

Note: Some sites with current groundwater quality data are approximately located and currently may not be counted in the correct subarea. Also, additional sites with current groundwater quality beyond this tabulation

exist but the locations are currently unavailable and unable to be counted at this time.

Frequency of Monitoring

With the exception of GeoTracker regulated facility sites in the county, current groundwater quality monitoring for TDS and/or EC typically occurs on a less frequent than annual basis. Nitrate monitoring on an annual or more frequent basis has occurred more often than monitoring for TDS, EC, and chloride (LSCE, 2010a, 2010b, and 2011).

It is recommended that wells added to the monitoring network for groundwater quality monitoring are sampled initially for general minerals and drinking water metals. These wells would include the six sites recommended for the purpose of evaluating groundwater/surface water interactions and also about 18 other sites in AOIs for groundwater quality monitoring as shown in **Table 4-2** and described above. It is also recommended that groundwater quality samples for similar parameters be collected the following year to affirm baseline conditions. It is recommended that groundwater quality monitoring occur on a triennial basis for general minerals and drinking water metals at the six sites recommended for groundwater/surface water evaluation. Following the baseline sampling and the one-year confirmation sampling, a 5-year frequency is recommended for the other 18 AOIs and where wells are volunteered for inclusion for monitoring in other subareas. A subset of analytes is recommended in intervening years (see further discussion below).

Field Methods

The methods and procedures used by DWR (1994) and USGS (http://water.usgs.gov/owq/FieldManual/) are detailed and extensive and are often used by counties and consultants as guidelines for the collection of water level measurements and water quality samples.

Prior to sampling a monitoring well, the static water level is measured. An electric sounder is used to measure the depth to groundwater from a specified reference point (usually the top of the well casing). Wellhead reference points are typically marked to provide consistency between measurements. Measurements are recorded to the nearest 0.01 foot. The static water level in conjunction with well construction information is used to calculate the volume of water in the well. This information is used to determine the minimum volume of water to be purged prior to sample collection.

Dedicated monitoring wells are typically purged and sampled using a portable submersible sampling pump. A discharge hose is attached to the top of the pump assembly through which purge water is discharged. Smaller-diameter tubing for sample collection is also attached to the top of the pump assembly. Discharge and sample collection tubings are attached to a manifold and are isolated from each other by a check valve.

Private water wells (domestic or agricultural), and also municipal and industrial wells, most often can be sampled using installed pumping equipment. Often these wells are routinely used for their intended purpose so the purging duration may be adjusted accordingly. Samples collected from existing supply wells should be collected near the wellhead (i.e., prior to any type of water storage tank).

Monitoring wells are purged of at least three well casing volumes and until indicator parameters have stabilized prior to sample retrieval. Stabilization is defined as three consecutive readings at 5-minute intervals where parameters do not vary by more than 5 percent. Purged groundwater is disposed of by spreading it on the ground at a reasonable distance from the sampled well to avoid the potential for purge water to enter the well casing again during the purging process.

The following indicator parameters (or field parameters) are typically monitored during the well purging:

- temperature (°C)
- pH (standard pH-units)
- electrical conductivity (µS/cm)
- dissolved oxygen (percent saturation)
- oxygen reduction potential (mV)
- turbidity (NTU)

Visual (color, occurrence of solids), olfactory (odor) and other observations (e.g., wellhead conditions, well access, ground conditions, and weather) are noted as appropriate.

After completion of purging activities, groundwater quality samples are often filtered in the field to remove turbidity and collected in laboratory-supplied bottles with or without preservative (depending on analyses to be conducted) with or without headspace. Filtering may also be conducted by the laboratory, in which case preservatives are added at the laboratory. Bottles are labeled with laboratory-supplied labels, immediately placed on ice, and kept in a dark ice chest (at 4 °C) until delivered to the laboratory. Samples are delivered to a laboratory certified through the State of California (Department of Public Health Environmental Laboratory Accreditation Program) with the proper chain-of-custody documentation within the required holding time. A chain-of-custody form is used to record sample identification numbers, type of samples (matrix), date and time of sample collection, and analytical tests requested. In addition, times, dates, and individuals who had possession of the samples are documented to record sample custody.

A field sheet is used to document equipment calibration, water level measurements, well purging activities, and the measurement of indicator parameters; an example is provided in **Appendix D**.

Quality Assurance Procedures

Quality assurance (QA) is an overall management plan used to guarantee the integrity of data collected by the monitoring program. This includes the discussed guidelines for groundwater level measurements, purging protocol, and sample handling and recordation. Quality control (QC) is a component of QA that includes analytical measurements used to evaluate the quality of the data. A brief discussion of field QC is followed by a discussion of laboratory QC requirements.

Field Quality Control

"Blind" duplicate field samples are collected to monitor the precision of the field sampling process and to assess laboratory performance. Blind duplicates are collected from at least 5 percent (1 in 20) of the total number of sample locations. The true identity of the duplicate sample is not noted on the chain-of-custody form, rather a unique identifier is provided. The identities of the blind duplicate samples are recorded in the field sheet, but the sampling locations of the blind field duplicates will not be revealed to the laboratory. "Field blanks" may also be employed to assure that the field procedures are not introducing any bias or contamination to the samples. The sample water for these is usually provided by the laboratory.

Lab Quality Control

Quality assurance and quality control samples (e.g., spiked samples, blank samples, duplicates) are employed by the laboratory to document the laboratory performance. Results of this testing are provided with each laboratory report.

Review of Laboratory Data Reports

Data validation includes a data completeness check of each laboratory analytical report. Specifically, this review includes:

- Review of data package completeness (ensuring that required QC and analytical results are provided);
- Review of the required reporting summary forms to determine if the QC requirements were met and to determine the effect of exceeded QC requirements on the precision, accuracy, and sensitivity of the data;
- Review of the overall data package to determine if contractual requirements were met; and
- Review of additional QA/QC parameters to determine technical usability of the data.

In addition, the data validation includes a comprehensive review of the following QA/QC parameters:

- Holding times (to assess potential for degradation that will affect accuracy);
- Blanks (to assess potential laboratory contamination);
- Matrix spikes/matrix spike duplicates and laboratory control samples (to assess accuracy of the methods and precision of the method relative to the specific sample matrix);
- Internal standards (to assess method accuracy and sensitivity);
- Compound reporting limits and method detection limits; and
- Field duplicate relative percent differences.

Parameters of Interest

The recommended water quality monitoring parameters are described below.

Baseline

During the initial groundwater sampling campaign (i.e., when "new" wells are added to the groundwater quality monitoring network), samples will be laboratory analyzed for general minerals and drinking water metals.

- General Minerals: Specific conductance (or electrical conductivity, EC), total dissolved solids, pH, sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), chloride (Cl), sulfate (SO_4), nitrate (NO_3), fluoride (F), alkalinity series (total, carbonate (CO_3), bicarbonate (HCO_3), hydroxide (OH)), and hardness;
- Drinking Water Metals: silver (Ag), aluminum (Al), arsenic (As) (total and dissolved), boron (B), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr) (total and dissolved), Hexavalent Cr, copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), vanadium (V), and zinc (Zn).

Affirm Baseline

During the second year of a monitoring well's inclusion in the groundwater quality monitoring network, samples will again be collected and analyzed for general minerals and drinking water metals to affirm the findings of the baseline sampling event.

Annual

It is recommended that samples be collected annually for analysis of field parameters and laboratory analyses for at least TDS, nitrate, and chloride. Additional analyses may be appropriate in selected subareas. The groundwater quality sampling locations/AOIs listed in **Table 4-2** are also locations where groundwater levels would be measured at least semi-annually. Therefore, it is recommended that groundwater quality sampling be coordinated with the spring water level measurements.

Triennial and/or Every Five Years

It is recommended that samples be collected triennially from the wells in the groundwater quality monitoring network for the six sites recommended for groundwater/surface water evaluation. A 5-year frequency is recommended for the other 18 AOIs, including the main NVF, Carneros, Jameson/American Canyon, and Napa River Marshes Subareas and also where wells are volunteered for inclusion in other subareas, and analyzed for general minerals and drinking water metals.

Special Studies or Areas of Interest

Some county subareas may have naturally occurring compounds or human-influenced compounds that are of special interest. Special studies may be appropriate to determine the presence, concentration, persistence and potential effects of such compounds, particularly when site-specific factors may potentially affect groundwater quality (e.g., mining areas, wastewater disposal, recycled water use, etc.).

5 Groundwater Data Management

This section describes how groundwater data obtained by the County will be managed, used, and shared. Specifically, this section discusses the types of data to be collected, the County's Data Management System (DMS), and which data may be shared with the State (e.g., DWR or other entities) and/or reported to the public.

5.1 Data Management Overview

An overview of the County's data management approach is provided in **Figure 5-1.** Data will be collected from a variety of sources and programs. The groundwater monitoring program includes public and volunteered wells[2] and also permit-required monitoring. Therefore, it is important that guidelines are established to ensure that data are managed according to the well owner's permission and/or as it relates to applicable permit conditions.

5.2 Data Management System (DMS)

The Napa County DMS has been constructed to incorporate existing and new data about groundwater resources in Napa County (LSCE, 2010a). The data incorporated in the DMS will be used on an ongoing basis by the County to evaluate countywide groundwater supply and quality conditions and functions as a secure central data storage location.

In order to ensure security and user flexibility, the database was designed using Microsoft Access 2000 and the .mdb database format. Access has the capacity to store historical and future data, up to a total of 2 GB of data, and the DMS can be transitioned to an enterprise database software system as necessary.

5.3 Data Use and Disclosure

In this section, the County's use and disclosure of collected data are described. A tiered participation approach in the volunteer groundwater monitoring program will be followed which allows property owners to choose their level of participation, including what data can be shared versus what data are to be kept confidential as required by State law (Water Code §13751, §13752). Well owners that volunteer their well for inclusion in the County's program would receive the groundwater information collected from their well. This may be provided on an annual basis and/or in periodic reports produced by the County.

5.3.1 Protected Data

The DMS contains certain protected information that will not be made publicly available. For example, drillers' reports and the specific well construction information contained therein are confidential. This data will be held as confidential unless permission is received from the well owner.

[2] As described in Section 4, the County has identified areas of interest where additional groundwater level and/or quality monitoring will help address data gaps. The County will be seeking well owners interested in volunteering their wells for inclusion in this program. All groundwater level and/or quality monitoring will be done by the County or representatives on behalf of the County (i.e., the monitoring is at no cost to participants and participants will receive information about groundwater beneath their property.

5.3.2 Data Sharing and Disclosure

The County is planning to implement an education and outreach program that includes communication to the public about opportunities to volunteer to have their well monitored as part of the County's groundwater monitoring program. The County is providing a tiered participation program as described below.

Napa County Program

Property owners interested in participating in the County program but who wish to keep their information confidential may elect to not have their well data (e.g., groundwater levels) reported to DWR's Water Data Library or as part of the CASGEM program. This means the County would only use the collected groundwater data (levels and/or quality) for public education and information but would display the data in publically distributed reports which ensure the owner's privacy.

Water Data Library

DWR maintains groundwater information in a database called the Water Data Library (WDL). Napa County reports groundwater level elevation data to DWR for inclusion in the WDL. Although well location information is included in the WDL, well construction information is not reported. This level of participation will be offered to property owner's volunteering their well for the County groundwater monitoring program. This will authorize the County to release water level information, but State mandated protected information will continue to be held as confidential.

CASGEM Program

Property owners interested in participating in the County's groundwater monitoring program and who are willing to provide the information required by the CASGEM program could also become participants in that program . Particularly, owners would recognize that if the County elects to include their well in the CASGEM program, the construction information for their well would be available online on DWR's site.

5.3.3 Reporting of Data

The County has historically routinely reported groundwater level data to DWR for inclusion in the WDL. Beginning in 2012, the County is also now reporting a subset of the groundwater level data collected by the County to DWR as part of the CASGEM program.
Any maps prepared from data in the DMS should represent well locations with large symbols. Names and addresses of well owners would be kept confidential. Additional information related to reporting is contained in **Section 6**.

5.3.4 Data from Other Sources

In addition to the groundwater level and quality data directly collected by the County, other groundwater data are available for the County to download and include in the evaluation of countywide groundwater conditions. Several different public agencies collect and maintain

groundwater data, including DWR, the USGS, the California Department of Public Health (DPH; GeoTracker-GAMA), and the State Water Resources Control Board (SWRCB; GeoTracker) (LSCE, 2010a). These sources can be accessed through the SWRCB website that summarizes the current data and databases available on the web at www.waterboards.ca.gov/resources/data_databases/. These programs and publicly available databases are continually evolving to expand and merge to create a more useful and powerful network of information. During the development of the County DMS, these data sources were combined with Napa County's own records in order to populate the Napa County DMS (LSCE, 2010a).

For gathering data that is collected by external agencies, a timeframe of about 2 to 3 years is a reasonable span between obtaining updates. This can be a sizeable effort to integrate multiple datasets, and planning should be done to avoid inconsistencies, gaps or duplications of data over a historical record.

6. REPORTING

To facilitate community understanding of Napa County groundwater and surface water systems, the reports prescribed in this section will be published in a manner that gives full and easy access to the public.

6.1 Annual Groundwater Monitoring Progress and Data Report

It is recommended that an Annual Groundwater Monitoring Progress and Data Report be prepared that includes a review of the groundwater monitoring program and network. Based on the data gathered from the current monitoring year, review of the historical record, water level and quality trend analyses, and consideration of issues of interest to the County and collaborating entities, the program may be adjusted as needed to accomplish the countywide groundwater resources goals and monitoring objectives. The Annual Progress Report will consider the stated goals and objectives of the groundwater monitoring program and include recommended modifications to the program and network, as needed.

It is recommended that the Progress Report also include a summary of the groundwater level and quality data collected by Napa County staff, including attachments containing tables that summarize the data and figures showing the measurement locations (this dataset and any accompanying discussion are not intended to be as comprehensive as the dataset and evaluation of groundwater level and quality conditions described below for Triennial Countywide Reporting).

6.2 Annual CASGEM Reporting

It is recommended that the County prepare an annual report summarizing the results and findings of the countywide CASGEM program. Each annual report will describe any changes to the current monitoring network and program, including recommended additions to the CASGEM program network.

6.3 Triennial Countywide Reporting on Groundwater Conditions

It is also recommended that the County prepare on a regular basis, approximately triennially, a report on countywide groundwater level and quality conditions and any other monitoring network modifications per the recommendations in this Plan which are for the purpose of meeting the County's groundwater level and quality monitoring objectives.

It is recommended that the Triennial Groundwater Conditions Report be prepared that includes the following:

- A summary of the groundwater level and quality data collected in Napa County by Napa County staff and other entities, including attachments containing tables that summarize the data and provide a reference to applicable water quality standards; figures showing the measurement locations;
- Figures illustrating groundwater level trends at locations throughout the County, especially in high priority subareas;

- Figures showing contours of equal groundwater elevation for the 1) Napa Valley Floor subareas (including Calistoga, St. Helena, Yountville, and Napa Subareas); 2) MST Subarea; and 3) other subareas as the groundwater level monitoring program evolves;
- Figures illustrating groundwater quality trends at locations throughout the County, especially in high priority subareas (time series plots would include TDS, nitrate and chloride and other selected constituents, depending on specific interests in individual subareas;
- A summary of coordinated efforts with other local, state and federal agencies pertaining to County and Regional groundwater conditions and reporting. Examples include summaries pertaining to interagency collaboration on Integrated Regional Water Management Planning and Implementation, Urban Water Management Plan updates, and Basin Plan updates.

As for the Annual Progress Report, it is recommended that the groundwater monitoring program and network be regularly reviewed and modifications to the groundwater monitoring network and program also included in the Triennial Report.

Interagency coordination is important for the ongoing program. Specifically, the local participants will benefit from efforts made toward systematic data collection and analyses and maintaining the DMS in a standardized format. The Triennial Report will include recommendations relevant to interagency data coordination, as needed.

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FIGURES

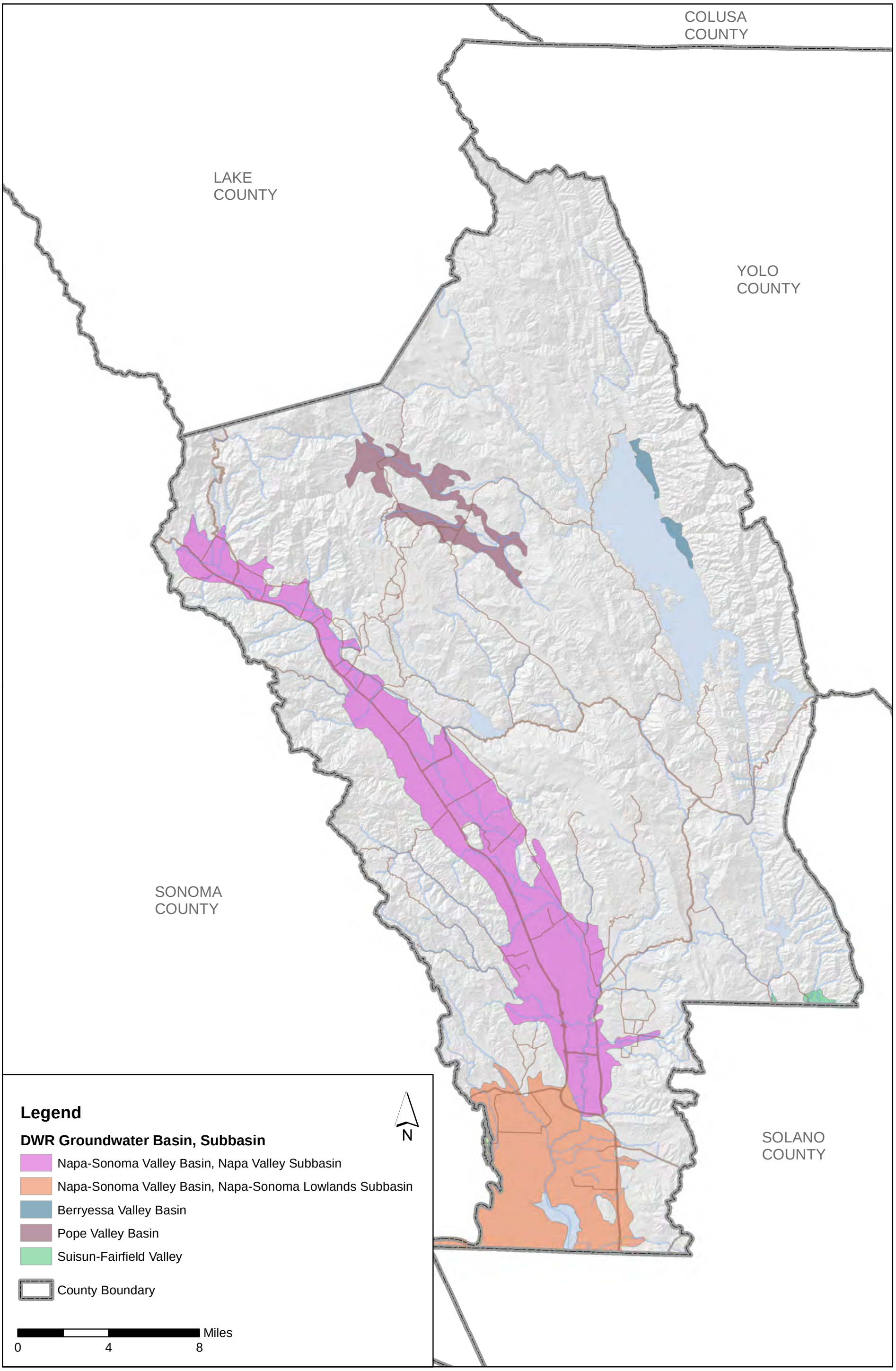

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Figure 2-1
Napa County Groundwater Basins
Napa County, CA

COLUSA COUNTY

LAKE COUNTY

YOLO COUNTY

SONOMA COUNTY

SOLANO COUNTY

Knoxville

Livermore Ranch

Pope Valley

Berryessa

Angwin

Central Interior Valleys

Napa Valley Floor Calistoga

Eastern Mountains

Napa Valley Floor St. Helena

Western Mountains

Napa Valley Floor Yountville

Napa Valley Floor MST

Napa Valley Floor Napa

Southern Interior Valleys

Carneros

Jameson/ American Canyon

Napa River Marshes

Legend

Subarea Boundary

County Boundary

N

Miles

0 4 8

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Figure 2-2
Napa County Subareas
Napa County, CA

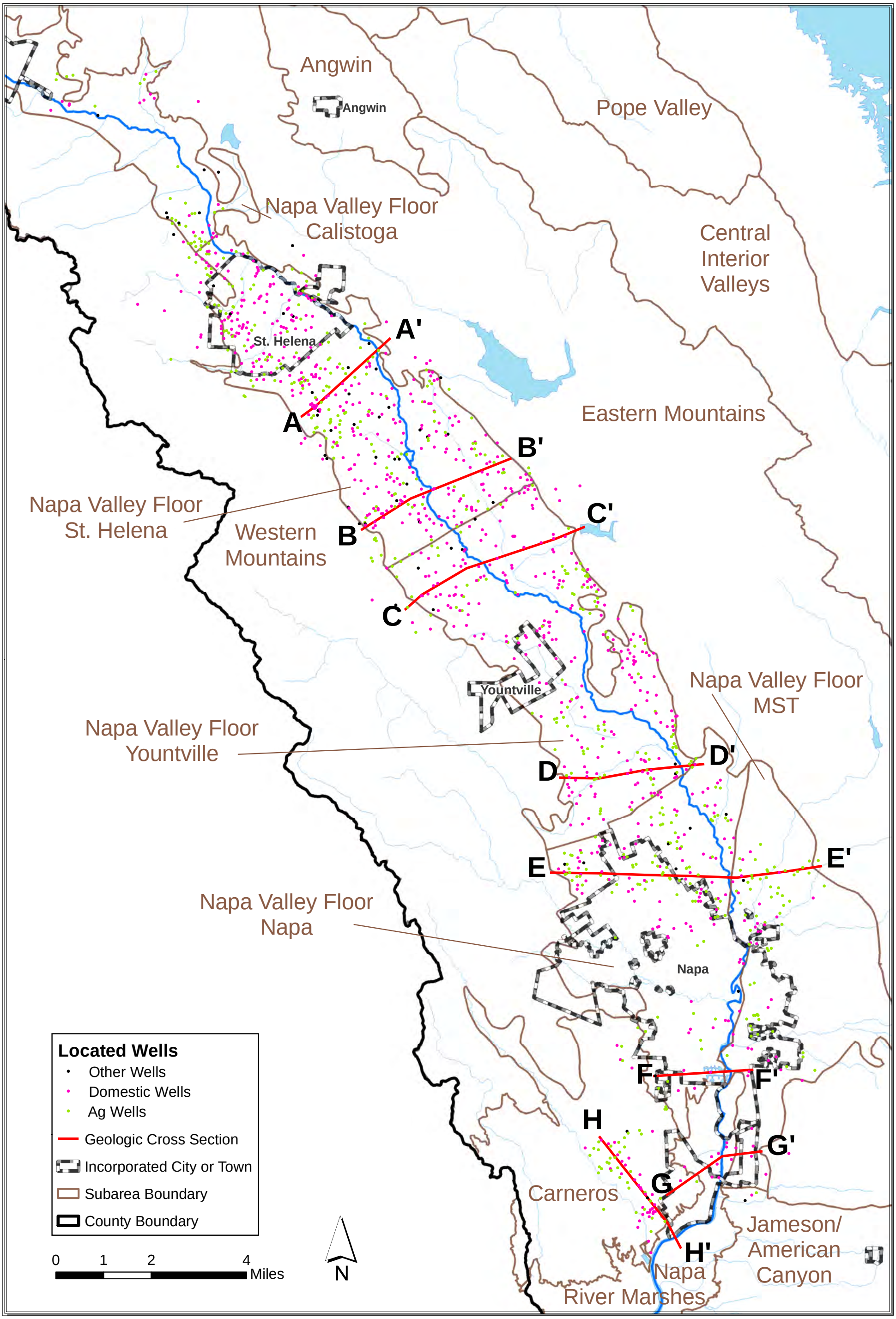

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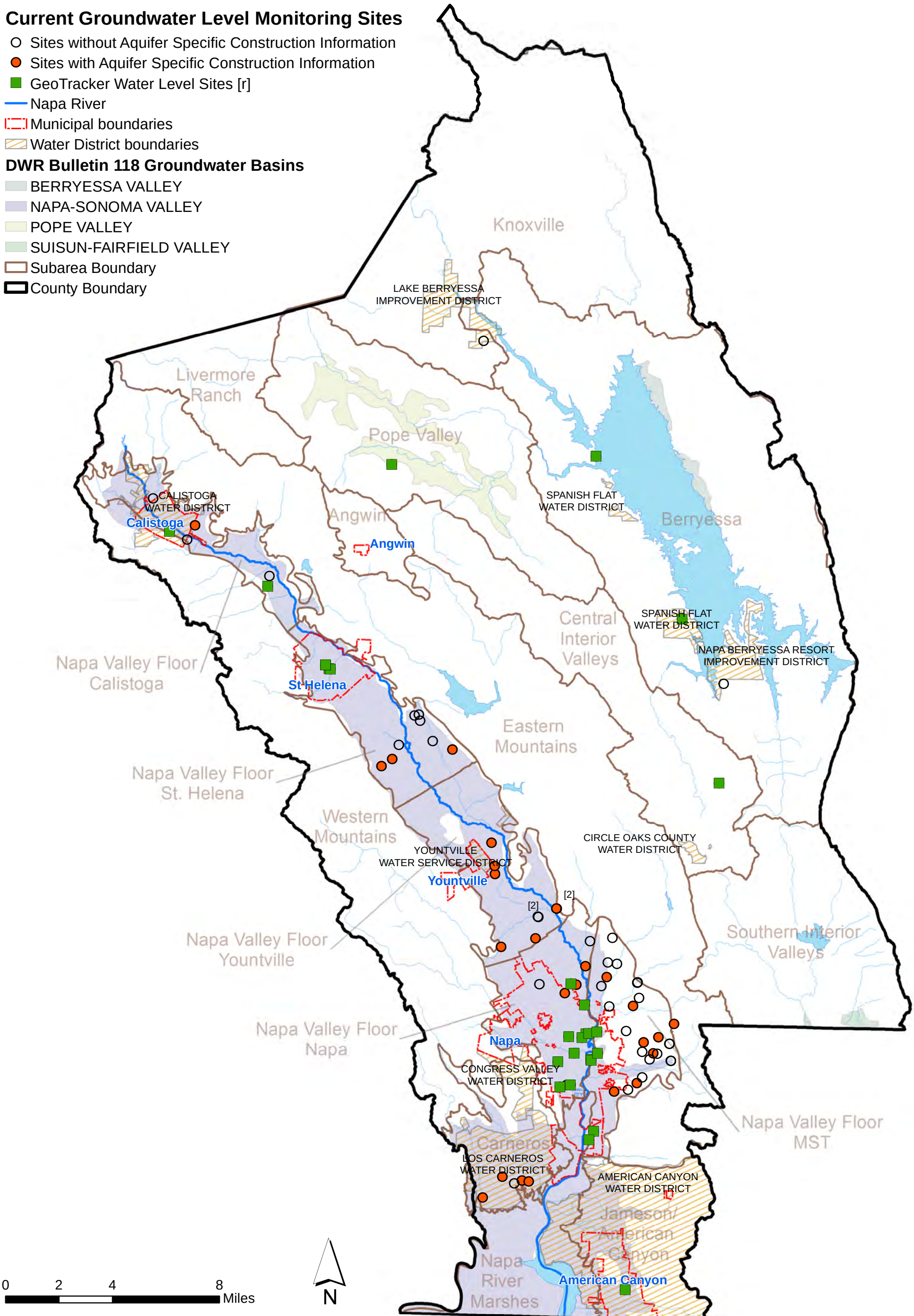
Figure 2-3
Geologic Cross Section Location Map

Current Groundwater Level Monitoring Sites

- Sites without Aquifer Specific Construction Information
- Sites with Aquifer Specific Construction Information
- GeoTracker Water Level Sites [r]
- Napa River
- Municipal boundaries
- Water District boundaries

DWR Bulletin 118 Groundwater Basins

- BERRYESSA VALLEY
- NAPA-SONOMA VALLEY
- POPE VALLEY
- SUISUN-FAIRFIELD VALLEY
- Subarea Boundary
- County Boundary



[r]: Regulated contaminant clean-up sites

[#]: Indicates the number of sites at a location where multiple sites are obscured by map scale.

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Figure 2-4
Current Groundwater Level Monitoring Sites in Napa County

Current Groundwater Quality Monitoring Sites

- Current DPH and DWR sites
- Current GeoTracker Groundwater Quality Sites
- Napa River
- Municipal boundaries
- Water District boundaries

DWR Bulletin 118 Groundwater Basins

- BERRYESSA VALLEY
- NAPA-SONOMA VALLEY
- POPE VALLEY
- SUISUN-FAIRFIELD VALLEY
- Subarea Boundary
- County Boundary

Knoxville
LAKE BERRYESSA IMPROVEMENT DISTRICT
Livermore Ranch
Pope Valley
CALISTOGA WATER DISTRICT
Calistoga
Angwin
Angwin
SPANISH FLAT WATER DISTRICT
Berryessa
Central Interior Valleys
SPANISH FLAT WATER DISTRICT
NAPA BERRYESSA RESORT IMPROVEMENT DISTRICT
Napa Valley Floor Calistoga
St Helena
Eastern Mountains
Napa Valley Floor St. Helena
Western Mountains
CIRCLE OAKS COUNTY WATER DISTRICT
YOUNTVILLE WATER SERVICE DISTRICT
Yountville
Napa Valley Floor Yountville
Southern Interior Valleys
Napa Valley Floor Napa
Napa
CONGRESS VALLEY WATER DISTRICT
Napa Valley Floor MST
Carneros
LOS CARNEROS WATER DISTRICT
AMERICAN CANYON WATER DISTRICT
Jameson/ American Canyon
Napa River Marshes
American Canyon

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N

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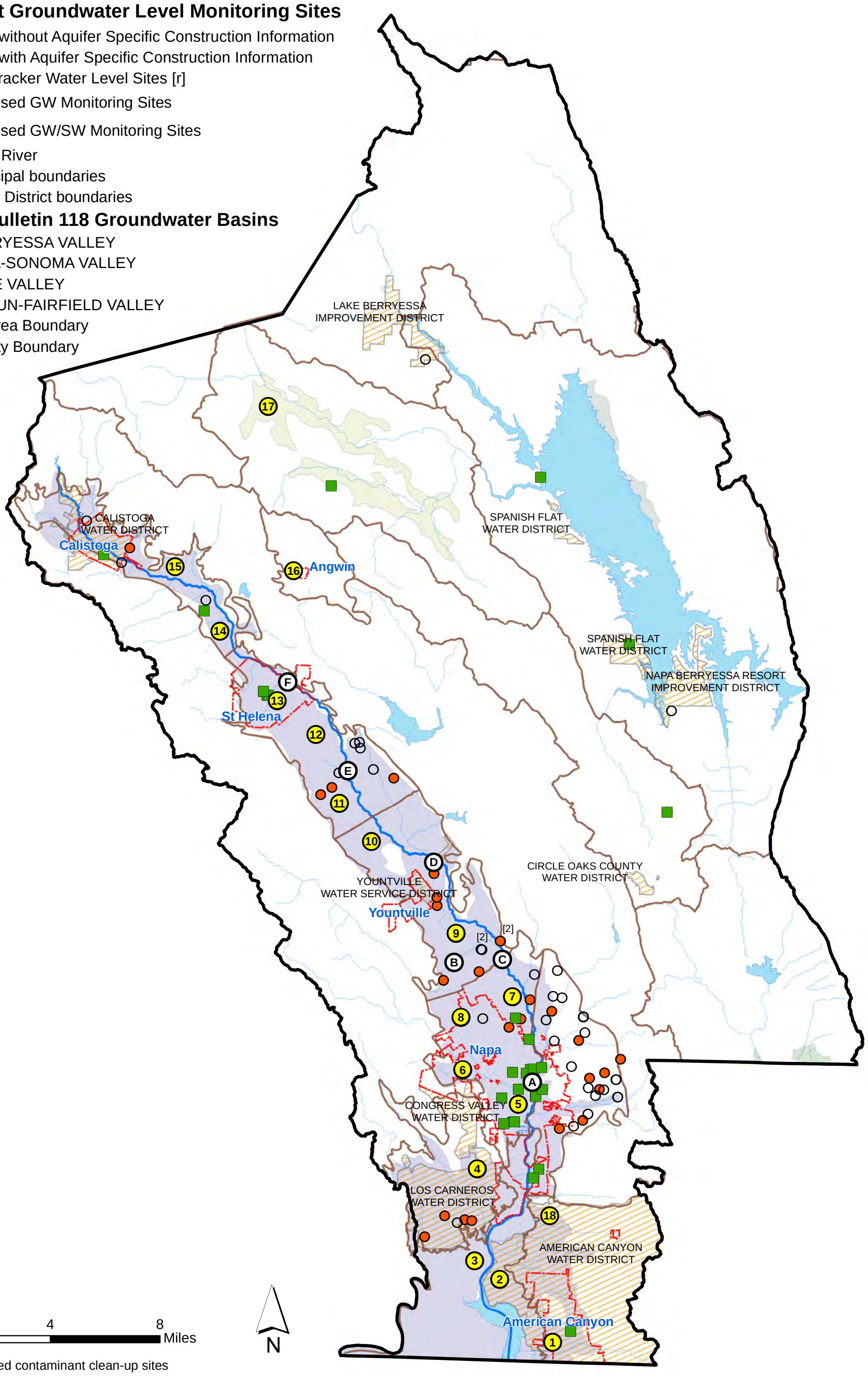
Figure 2-5
Current Groundwater Quality Monitoring Sites in Napa County

Current Groundwater Level Monitoring Sites

- Sites without Aquifer Specific Construction Information
- Sites with Aquifer Specific Construction Information
- GeoTracker Water Level Sites [r]
- Proposed GW Monitoring Sites
- Proposed GW/SW Monitoring Sites
- Napa River
- Municipal boundaries
- Water District boundaries

DWR Bulletin 118 Groundwater Basins

- BERRYESSA VALLEY
- NAPA-SONOMA VALLEY
- POPE VALLEY
- SUISUN-FAIRFIELD VALLEY
- Subarea Boundary
- County Boundary



[r]: Regulated contaminant clean-up sites

[#]: Indicates the number of sites at a location where multiple sites are obscured by map scale.

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Figure 4-1
Current and Proposed Groundwater Level Monitoring Sites in Napa County

Current Groundwater Quality Monitoring Sites

- Current DPH and DWR sites
- Current GeoTracker Groundwater Quality Sites
- Napa River
- Municipal boundaries
- Water District boundaries

DWR Bulletin 118 Groundwater Basins

- BERRYESSA VALLEY
- NAPA-SONOMA VALLEY
- POPE VALLEY
- SUISUN-FAIRFIELD VALLEY
- Subarea Boundary
- County Boundary

LAKE BERRYESSA IMPROVEMENT DISTRICT
CALISTOGA WATER DISTRICT
Calistoga
Angwin
SPANISH FLAT WATER DISTRICT
SPANISH FLAT WATER DISTRICT
NAPA BERRYESSA RESORT IMPROVEMENT DISTRICT
St Helena
YOUNTVILLE WATER SERVICE DISTRICT
Yountville
CIRCLE OAKS COUNTY WATER DISTRICT
Napa
CONGRESS VALLEY WATER DISTRICT
LOS CARNEROS WATER DISTRICT
AMERICAN CANYON WATER DISTRICT
American Canyon

17 15 16 14 F 13 12 E 11 10 D 9 B C 7 8 6 A 5 4 18 3 2 1

0 2 4 8 Miles

N

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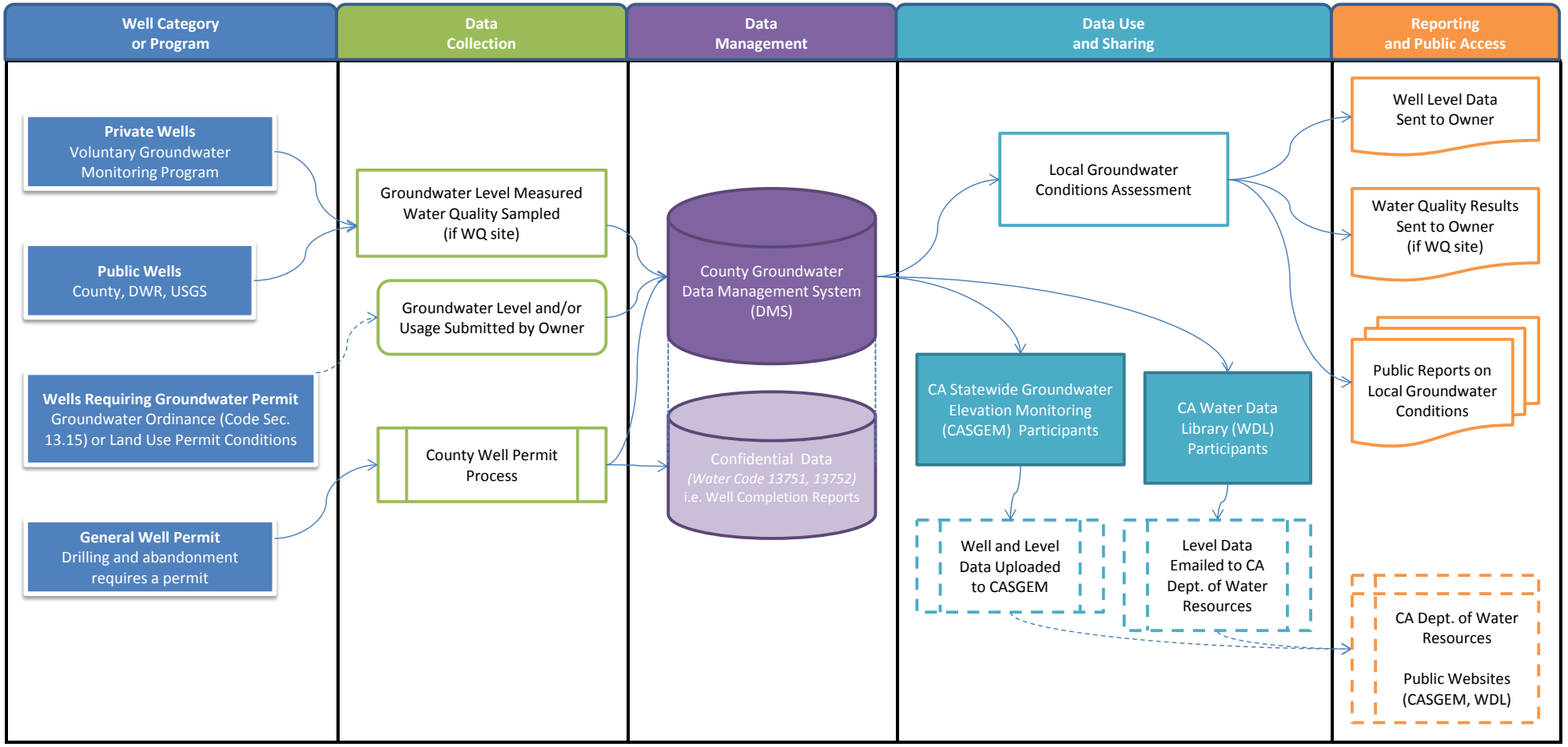
Figure 4-2
Current and Proposed Groundwater Quality Monitoring Sites in Napa County

Figure 5-1 Groundwater Data Collection, Management, Use, and Reporting



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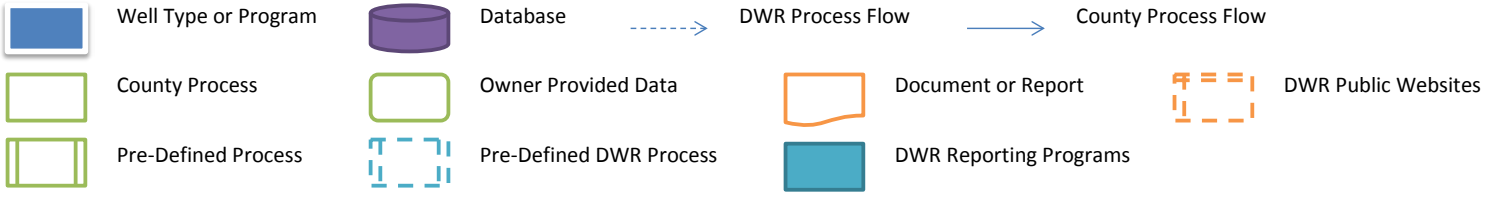


APPENDIX A

Summaries of 2011 and 2013 Groundwater Report Findings and Future Groundwater Level and Quality Monitoring Objectives

Summaries of 2011 and 2013 Groundwater Report Findings and Objectives
Groundwater Level Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Level Data (LSCE and MBK Eng. 2013)	Future Groundwater Level Monitoring		Monitoring Needs	Findings on GW Level Conditions (LSCE, 2011a)	General Comments re Monitoring Needs	Improve understanding of occurrence and movement	Factors affecting levels & trends	Fill Data Gaps	Develop/refine GW budget (include recharge)	Further evaluate sw/gw potential exchange	Potential for saltwater intrusion
		Relative Priority (2011 Prelim)	Action (Expand/ Refine)									
Napa Valley Floor-Calistoga	**6**	**H**	E	**SP, SW**	*Water levels are generally stable and depths to gw are shallow; 156 wells provide data, about 3/4 of the wells have limited records.*	**Need to optimize current monitoring locations to ensure that the existing monitoring locations are adequately distributed throughout the subarea in aquifers of interest.**	**X**	**X**	**X**	**X**	**X**	
Napa Valley Floor-MST	**29**	**H**	R	**SP, SW**	*Wells with records show long term declining water levels; some have a repeating pattern of declining then stabilizing and never recovering, while others have a recent steady continuous decline; 286 wells provide data, half with limited records and more than half measured recently.*	**Need to optimize current monitoring locations to ensure the northern, central, and southern areas of MST have representative distribution of MWs in aquifers of interest. Would provide essential data to assess how existing gw development regulations are effective in managing gw resources in this area.**	**X**	**X**	**X**	**X**	**X**	
Napa Valley Floor-Napa	**18**	**H**	R	**SP, SW**	*Water levels are generally stable except toward the east where declines of 20 feet have been observed close to the northern MST; 273 wells provide data, most with limited records.*	**Need to optimize current monitoring locations to ensure that the existing monitoring locations are adequately distributed throughout the subarea in aquifers of interest.**	**X**	**X**	**X**	**X**	**X**	

Summaries of 2011 and 2013 Groundwater Report Findings and Objectives
Groundwater Level Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Level Data (LSCE and MBK Eng. 2013)	Future Groundwater Level Monitoring		Monitoring Needs	Findings on GW Level Conditions (LSCE, 2011a)	General Comments re Monitoring Needs	Improve understanding of occurrence and movement	Factors affecting levels & trends	Fill Data Gaps	Develop/refine GW budget (include recharge)	Further evaluate sw/gw potential exchange	Potential for saltwater intrusion
		Relative Priority (2011 Prelim)	Action (Expand/ Refine)									
Napa Valley Floor-St. Helena	**12**	**H**	E	**SP, SW**	*Water levels are generally stable and depths to water are shallow; 70 wells provide data, most wells have good records.*	**Need to optimize current monitoring locations to ensure that the existing monitoring locations are adequately distributed throughout the subarea in aquifers of interest.**	**X**	**X**	**X**	**X**	**X**	
Napa Valley Floor-Yountville	**9**	**H**	E	**SP, SW**	*Water levels are generally stable with seasonal fluctuations; fewer wells have data (31 wells) compared to the rest of the Valley Floor, and fewer wells have good records or recent data.*	**Need to optimize current monitoring locations to ensure that the existing monitoring locations are adequately distributed throughout the subarea in aquifers of interest.**	**X**	**X**	**X**	**X**	**X**	
Carneros	**5**	**H**	E	**B**	*No current groundwater level data, but a good record exists for 7 wells with data between 1962 and 1978.*	**Very limited historical data and no current data. Additional data collection is recommended to investigate groundwater conditions under existing development conditions and for any planned additional use of groundwater resources.**	**X**	**X**	**X**	**X**		**X**
Jameson/American Canyon	1	M	E	B	*Limited groundwater level data; all recent data are from regulated facility monitoring wells.*	**Very limited data for the most part, however, short term development of groundwater resources are not anticipated on a significant scale.**	X	X	X	X		X

Summaries of 2011 and 2013 Groundwater Report Findings and Objectives Groundwater Level Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Level Data (LSCE and MBK Eng. 2013)	Future Groundwater Level Monitoring		Monitoring Needs	Findings on GW Level Conditions (LSCE, 2011a)	General Comments re Monitoring Needs	Improve understanding of occurrence and movement	Factors affecting levels & trends	Fill Data Gaps	Develop/refine GW budget (include recharge)	Further evaluate sw/gw potential exchange	Potential for saltwater intrusion
		Relative Priority (2011 Prelim)	Action (Expand/ Refine)									
Napa River Marshes	1	M	E	SP, SW	*Limited groundwater level data; all data are from regulated facility monitoring wells; no historical data pre-2000.*	Very limited data for the most part, however, short term development of groundwater resources are not anticipated on a significant scale.	X	X	X	X		X
Angwin	0	M	E	B	*No current groundwater level data; 10 wells are from one regulated facility site with data over three years; no historical data pre-2002.*	No data; short term development of gw resources are not anticipated on a significant scale.	X	X	X	X		
Berryessa	3	M	E	B	*Limited record and spatial distribution; most wells with data are monitoring wells on three different regulated facilities; no historic data pre-2002.*	Very limited data for the most part, however, short term development of groundwater resources are not anticipated on a significant scale.	X	X	X			
Central Interior Valleys	1	M	E	B	*Limited data; all data from three regulated facilities' monitoring wells; no historical data pre-2002.*	Very limited data for the most part, however, short term development of groundwater resources are not anticipated on a significant scale.	X	X	X			
Eastern Mountains	0	M	E	B	*Limited data and spatial distribution; one well near the MST shows recent declines similar to those found in the MST.*	No data; short term development of gw resources are not anticipated on a significant scale.	X	X	X			

Summaries of 2011 and 2013 Groundwater Report Findings and Objectives Groundwater Level Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Level Data (LSCE and MBK Eng. 2013)	Future Groundwater Level Monitoring		Monitoring Needs	Findings on GW Level Conditions (LSCE, 2011a)	General Comments re Monitoring Needs	Improve understanding of occurrence and movement	Factors affecting levels & trends	Fill Data Gaps	Develop/refine GW budget (include recharge)	Further evaluate sw/gw potential exchange	Potential for saltwater intrusion
		Relative Priority (2011 Prelim)	Action (Expand/ Refine)									
Knoxville	1	M	E	B	*Limited record and spatial distribution; no historic groundwater level data and a very short period of record.*	Very limited data for the most part, however, short term development of groundwater resources are not anticipated on a significant scale.	X	X	X			
Livermore Ranch	0	L	E	B	*No data.*	No data; short term development of gw resources are not anticipated on a significant scale.	X	X	X			
Pope Valley	1	H	E	B	*Limited groundwater level data; all data are from two regulated facilities' monitoring wells; no historical data pre-2002.*	Very limited existing data. Additional data collection is recommended to investigate groundwater conditions for planned use of groundwater resources.	X	X	X			
Southern Interior Valleys	0	L	E	B	*No data.*	No data; short term development of gw resources are not anticipated on a significant scale.	X	X	X			
Western Mountains	0	L	E	B	*No data.*	No data; short term development of gw resources are not anticipated on a significant scale.	X	X	X			
Total	**87**											

Groundwater Level Notes

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2011 or later.“Future” refers to recommended monitoring locations.

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells coordinated with recent geologic investigations that are or will be conducted)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs:
SP = Improve horizontal and/or vertical spatial distribution of data;
SW =identify appropriate monitoring site to evaluate surface water -groundwater recharge/discharge mechanisms;
B = Basic data needed to accomplish groundwater level monitoring objectives

Summaries of 2011 Groundwater Report Findings and Objectives for Groundwater Quality Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Quality Data	Future Groundwater Quality Monitoring		Monitoring Needs	Findings GW Quality Conditions (LSCE, 2011a)	Constits. of Concern	Baseline conditions &spatial differences	Fill Data Gaps	Occurrence & factors related to natural or other constituents	Baseline conditions in areas of potential saltwater intrusion	Assess changes, trends, factors contrib. to change	Other
		Relative Priority (2011 Preilm)	Action (Expand/ Refine)									
Napa Valley Floor-Calistoga	20	M	R	SP,C	*Limited data record, minimal historical record*	*As, B*	X	X	X		X	
Napa Valley Floor-MST	**16**	**H**	R	**SP,C**	*Very limited long-term records*	*As, B, Fe, Mn, Na*	**X**	**X**	**X**		**X**	
Napa Valley Floor-Napa	21	M	R	SP,C	*Generally good water quality; most wells have limited data records and very little historical data*	*Na, As, NO3*	X	X	X		X	
Napa Valley Floor-St. Helena	31	M	R	SP,C	*Generally good water quality; most wells have limited data records and very little historical data*	*As, NO3*	X	X	X		X	
Napa Valley Floor-Yountville	14	M	R	SP,C	*Generally good water quality; most wells have limited data records and very little historical data*	*As, NO3*	X	X	X		X	
Carneros	**9**	**H**	R	**SP,C**	*Limited data record; minimal historic and recent records; poor water quality common; possible increasing recent trend seen in EC, chloride, and TDS*	*Cl, EC, TDS*	**X**	**X**	**X**	**X**	**X**	
Jameson/American Canyon	**3**	**H**	E	**B,SP,C**	*No recent data post-1998; generally poor water quality from a very limited data set; increasing chloride and EC levels*	*Cl, EC, Na, NO3, TDS*	**X**	**X**	**X**	**X**	**X**	

Summaries of 2011 Groundwater Report Findings and Objectives for Groundwater Quality Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Quality Data	Future Groundwater Quality Monitoring		Monitoring Needs	Findings GW Quality Conditions (LSCE, 2011a)	Constits. of Concern	Baseline conditions &spatial differences	Fill Data Gaps	Occurrence & factors related to natural or other constituents	Baseline conditions in areas of potential saltwater intrusion	Assess changes, trends, factors contrib. to change	Other
		Relative Priority (2011 Preilm)	Action (Expand/ Refine)									
Napa River Marshes	6	M	E	B,SP,C	*Very limited long-term records; one well with historic data; generally poor water quality*	*Cl, EC, Na, NO3, TDS*	X	X	X	X	X	
Angwin	4	M	E	B,C	*No historic records; all measurements from two sites (ten wells total); generally good water quality*	*Fe, Mn*	X	X	X		X	
Berryessa	6	M	E	B,C	*Poor coverage for majority of constituents; no long-term records*	*EC, TDS*	X	X	X		X	
Central Interior Valleys	6	M	R	B,SP,C	*No historic records pre-2001; poor coverage for majority of constituents; no long-term data*	*TDS*	X	X	X		X	
Eastern Mountains	25	M	E	B,C	*Limited historic records; poor spatial distribution; generally good water quality*	*Fe, Mn*	X	X	X		X	
Knoxville	0	M	E	B,C	*Limited to one site with five monitoring wells; generally poor quality and no long-term records*	*B, Cl, EC, Na, TDS*	X	X	X		X	
Livermore Ranch	0	L	E	B,C	*No groundwater quality data available*	*unknown*	X	X	X		X	
Pope Valley	6	L	E	B,C	*No historic records; all measurements from two sites (seven wells total); generally good water quality from constituents with data*	*Fe, Mn*	X	X	X		X	

Summaries of 2011 Groundwater Report Findings and Objectives for Groundwater Quality Monitoring Sites, Napa County

Subarea	No. Sites with Current GW Quality Data	Future Groundwater Quality Monitoring		Monitoring Needs	Findings GW Quality Conditions (LSCE, 2011a)	Constits. of Concern	Baseline conditions &spatial differences	Fill Data Gaps	Occurrence & factors related to natural or other constituents	Baseline conditions in areas of potential saltwater intrusion	Assess changes, trends, factors contrib. to change	Other
		Relative Priority (2011 Preilm)	Action (Expand/ Refine)									
Southern Interior Valleys	0	L	E	B,C	*No historic records; poor spatial coverage (only three wells with data); generally good quality*	*As, Na*	X	X	X		X	
Western Mountains	10	L	R	B,C	*Very limited historic and current records (12 wells total); generally good quality*	*Fe, Mn*	X	X	X		X	
Total	**177**											

Groundwater Quality Notes

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2008 or later."Future" refers to recommended monitoring locations.

L = Low Priority; add groundwater quality and also level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater quality and also level monitoring

H = High Priority; add groundwater quality and also level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information and as the well may be available for monitoring; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells (coordinate with potential geologic investigations that may be conducted in selected areas)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs: SP = Improve horizontal and/or vertical spatial distribution of data; B = Basic data needed to accomplish groundwater level monitoring objectives; C = Coordinate with groundwater level monitoring

Note: Some sites with current groundwater quality data are approximately located and currently may not be counted in the correct subarea. Also, additional sites with current groundwater quality beyond this tabulation exist but the locations are currently unavailable and unable to be counted at this time.

APPENDIX B

Summaries of Current Groundwater Level and Groundwater Quality Monitoring Locations

Summary of Current Groundwater Level Monitoring Locations

	WellID	State Well Number	Year Start	Construction Date (yyyymmdd)	Well Depth (ft)	Hole Depth (ft)	Screen Interval (ft)
Napa Valley Floor-Calistoga	NapaCounty-127	009N007W25N001M	1962	19580310	149	149	unk
	NapaCounty-129	008N006W06L004M	1962	19620719	253	253	unk
	NapaCounty-128	009N006W31Q001M	1962	19620719	50	50	unk
	08N06W10Q001M	008N006W10Q001M	1949		200		unk
	T0605500250MW-1		2005		24.83		10 - 25
	T0605500272MW-1		2008				unk
Napa Valley Floor-St. Helena	NapaCounty-131	007N005W16L001M	1963	193907	221	221	7 - sections
	NapaCounty-132	007N005W14B002M	1962		265	265	25 - 265
	NapaCounty-138	007N005W16N002M	1949		321	321	unk
	07N05W09Q002M	007N005W09Q002M	1949		232		unk
	T0605500061MW-8		2005		20		6 - 20
	T0605500168MW-6		1998		18		3 - 18
	T0605500190MW-1		2001		22.5		7.5 - 22.5
	T0605500190MW-1		2002		18.59		unk
	CityofNapa-BV		2002		unk		unk
	CityofNapa-C1		2002		unk		unk
	CityofNapa-Woods1		2002		unk		unk
	CityofNapa-Woods2		2002		unk		unk
	NapaCounty-133	007N004W31M001M	1978	19720415	120	120	20 - 120

	WellID	State Well Number	Year Start	Construction Date (yyyymmdd)	Well Depth (ft)	Hole Depth (ft)	Screen Interval (ft)
Napa Valley Floor-Yountville	NapaCounty-135	006N004W19B001M	1979	19620720	125	125	unk
	NapaCounty-125	006N004W09Q001M	1979	19710823	160	163	63 - 160
	NapaCounty-126	006N004W09Q002M	1984	19711116	345	345	140 - 345
	NapaCounty-134	006N004W06L002M	1963	19550801	260	264	160 - 260
	NapaCounty-139	006N004W17R002M	1978	19770125	120	120	40 - 120
	NapaCounty-151	006N004W17Ax	2012				unk
	06N04W17A001M	006N004W17A001M	1949		250		unk
	TownofYountville-MW1			20041103	300	320	105 - 300
Napa Valley Floor-Napa	NapaCounty-76	006N004W15R003M	2000				unk
	NapaCounty-75	006N004W22R001M	1978	19710719	205	208	45 - 205
	NapaCounty-136	006N004W27N001M	1979	19620720	120	120	unk
	NapaCounty-152	006N004W28Mx	2012				unk
	06N04W27L002M	006N004W27L002M	1966	19660609	120	122	60 - 120
	05N04W15E001M	005N004W15E001M	1949		158		unk
	SL0605536682MW-1		2005		24		unk
	T0605500008MW-3		2005	20050721	15		3 - 15
	T0605500009MW1		2005	19920301	14		3 - 14
	T0605500044C-4		2002		12.63		10 - 30
	T0605500110KMW-1		2003	19900815	19.65	26	9.5 - 24.5
	T0605500124MW-1		2002		25		unk
	T0605500164EX-1		2003	2002112	37	37	10 - 35

	WellID	State Well Number	Year Start	Construction Date (yyyymmdd)	Well Depth (ft)	Hole Depth (ft)	Screen Interval (ft)
	T0605500212MW-1		2003		20	21.5	4 - 20
	T0605514064MW1		2005				unk
	T0605547200MW-1		2008				unk
	T0605575085MW-1		2009				unk
	T0605598080MW-1		2005				unk
Napa Valley Floor-MST	NapaCounty-118	005N003W07B00_My	2001			0	unk
	NapaCounty-122	006N004W26L00_M	2001			0	unk
	NapaCounty-142	006N004W25G00_M	2001			0	unk
	NapaCounty-149	005N003W08E00_M	2010				unk
	NapaCounty-18	005N004W13G004M	2000	19760714	189	210	unk
	NapaCounty-22	005N003W08E001M	2000	19680416	135	140	unk
	NapaCounty-29	005N004W01F003M	2000			0	unk
	NapaCounty-35	005N003W18D001M	2000			0	unk
	NapaCounty-4	006N004W14Q001M	2000	19890913	385	390	unk
	NapaCounty-51	006N004W25G001M	2000			0	unk
	NapaCounty-69	006N004W35G005M	2000			0	unk
	NapaCounty-72	005N003W07D003M	2000	19971007	245	245	unk
	NapaCounty-81	005N003W07F003M	2000	19880725	290	290	unk
	NapaCounty-98	006N004W36A001M	2000			0	unk
	NapaCounty-10	005N003W05M001M	1979		320		unk
	NapaCounty-148	005N003W05M00_M	2009	20090805			unk

	WellID	State Well Number	Year Start	Construction Date (yyyymmdd)	Well Depth (ft)	Hole Depth (ft)	Screen Interval (ft)
	NapaCounty-2	006N004W23J001M	1979		700		unk
	NapaCounty-20	005N003W07C003M	1978	19771208	208	208	130 - 207
	NapaCounty-56	006N004W26G001M	1978	19760828	210	210	30 - 210
	NapaCounty-95	006N004W36G001M	1979	19770110	195	340	155 - 185
	NapaCounty-137	005N004W13H001M	1979	19620716	364	364	unk
	NapaCounty-43	006N004W23Q003M	1978		310		unk
	NapaCounty-49	005N004W14J003M	1989		399		unk
	NapaCounty-74	005N003W06M001M	1999	19880818	300	300	unk
	NapaCounty-91	005N003W06B002M	1992	19860815	415	415	315 - 415
	NapaCounty-92	005N003W06A001M	1999		368	0	unk
	L10002804480DW-1		2005				unk
	T0605500138S-3		2003	20030428	30	30	4 - 15
	T0605500140MW-1		2000	19910119	24.86	26	11 - 26
Carneros	NapaCounty-150	004N004W05C001M	2011		155		unk
	NapaCounty-153	004N004W05A001M	2012	19780508	200	210	60 - 200
	NapaCounty-154	005N004W31R001M	2012	19900828	300	320	60 - 295
	NapaCounty-155	004N004W06M001M	2012	20030813	220	220	80 - 220
	04N04W05D002M	004N004W05D002M	1951		60		unk
Jameson/ American Canyon	T0605500240MW-4		2007		14.5		unk
Napa River Marshes	L10002804480DW-2		2005				unk

	WellID	State Well Number	Year Start	Construction Date (yyyymmdd)	Well Depth (ft)	Hole Depth (ft)	Screen Interval (ft)
	NBRID_MW2		2007				unk
	T0605500304MW-1		2002				unk
Berryessa	T0605591908MW-1		2006		34		unk
Central Interior Valleys	T0605500279MW1		2002				unk
Knoxville	LBRID_MW1		2006				unk
Pope Valley	T0605593602MW-1		2002				unk

Summary of Current Groundwater Quality Monitoring Locations

	WellID	SRC	SYS_NO	SITE_TYPE
Napa Valley Floor - Calistoga	2800026	DPH	TRINCHERO WINERY	
	2800030	DPH	ENVY WINES	
	2800508	DPH	CUVAISON VINEYARD	
	2800516	DPH	TUCKER ACRES MUTUAL WATER CO.	
	2800555	DPH	TWOMEY CELLARS	
	2800587	DPH	DUFFY S MYRTLEDALE RESORT	
	2800648	DPH	WINE COUNTRY INN	
	2800741	DPH	ST. HELENA PREMIUM OUTLETS	
	2800742	DPH	GOLDEN HAVEN MOTEL	
	2801004	DPH	CHATEAU MONTELENA WINERY	
	2801007	DPH	CLOS PEGASE WINERY	
	2801015	DPH	FRANK FAMILY VINEYARDS	
	2802715	DPH	NORMAN ALUMBAUGH CO., INC.	
	2810002	DPH	CALISTOGA, CITY OF	
	2810300	DPH	CSP-BALE GRIST MILL STATE PARK	
	L10001344067B-11	Geotracker	L10001344067	
	T0605500196MW-1	Geotracker	T0605500196	
	T0605500250MW-1	Geotracker	T0605500250	
	T0605500259EB1	Geotracker	T0605500259	
	T0605500272EB	Geotracker	T0605500272	
Napa Valley Floor - St. Helena	2800027	DPH	NICKEL & NICKEL WINERY	
	2800035	DPH	RIVER RANCH FARM WORKER CENTER	
	2800536	DPH	GRGICH HILLS	
	2800556	DPH	BROKEN HILL 1 LLC	
	2800562	DPH	FRANCISCAN WINERY	

	WellID	SRC	SYS_NO	SITE_TYPE
	2800589	DPH	WHITEHALL LANE WINERY	
	2800609	DPH	PHELPS VINEYARDS	
	2800749	DPH	KENT RASMUSSEN WINERY	
	2801012	DPH	ALPHA AND OMEGA WINERY	
	2801022	DPH	MILAT WINERY	
	2801026	DPH	OPUS ONE WINERY	
	2801027	DPH	PEJU PROVINCE	
	2801031	DPH	RAYMOND VINEYARD & CELLAR	
	2801037	DPH	SEQUOIA GROVE VINEYARDS	
	2801038	DPH	SILVER OAKS WINE CELLARS	
	2801045	DPH	ST. CLEMENT VINEYARDS INC.	
	2801046	DPH	ST. SUPERY WINERY	
	2801049	DPH	THE RANCH WINERY	
	2801070	DPH	BERINGER VINEYARDS	
	2801073	DPH	PROVENANCE VINEYARDS	
	2801075	DPH	CAKEBREAD CELLAR	
	2801088	DPH	V. SATTUI WINERY	
	2803886	DPH	RUTHERFORD GROVE WINERY	
	2803912	DPH	BEAULIEU VINEYARD	
	2810004	DPH	ST. HELENA, CITY OF	
	L10003472156MW-1	Geotracker	L10003472156	
	SL0605506371MW-1	Geotracker	SL0605506371	
	T0605500061EW-1	Geotracker	T0605500061	
	T0605500143MW-1	Geotracker	T0605500143	
	T0605500168EW-1	Geotracker	T0605500168	
	T0605500190MW-1	Geotracker	T0605500190	
	2800299	DPH	FAR NIENTE WINERY	

	WellID	SRC	SYS_NO	SITE_TYPE
Napa Valley Floor - Yountville	2800302	DPH	HARTWELL WINERY	
	2800557	DPH	CASTLE TROVE, INC.	
	2800736	DPH	DOMAINE CHANDON	
	2801006	DPH	CLOS DU VAL WINE CO.	
	2801010	DPH	COSENTINO WINERY	
	2801028	DPH	CARDINALE ESTATE	
	2801029	DPH	PINE RIDGE WINERY	
	2801041	DPH	SILVERADO VINEYARDS	
	2801042	DPH	SINSKEY WINERY	
	2801047	DPH	STAG S LEAP WINE CELLARS	
	2801077	DPH	CHIMNEY ROCK WINERY	
	2803911	DPH	DOMINUS ESTATE WINERY	
	2810007	DPH	TOWN OF YOUNTVILLE	
Napa Valley Floor - Napa	2800635	DPH	STRACK W.D. WATER	
	2801020	DPH	ESPINOZA WATER SYSTEM	
	SL0605536682MW-1	Geotracker	SL0605536682	
	T0605500008BC-1	Geotracker	T0605500008	
	T0605500009EW-1	Geotracker	T0605500009	
	T0605500044C-4	Geotracker	T0605500044	
	T0605500110MW-1	Geotracker	T0605500110	
	T0605500124MW-1	Geotracker	T0605500124	
	T0605500164EFF	Geotracker	T0605500164	
	T0605500165EFF	Geotracker	T0605500165	
	T0605500212MW-1	Geotracker	T0605500212	
	T0605500256MW-1	Geotracker	T0605500256	
	T0605500261MW-2	Geotracker	T0605500261	
	T0605514064MW1	Geotracker	T0605514064	

	WellID	SRC	SYS_NO	SITE_TYPE
	T0605522317DP-1	Geotracker	T0605522317	
	T06055472002285DW	Geotracker	T0605547200	
	T0605575085B-1	Geotracker	T0605575085	
	T0605591205MW-1	Geotracker	T0605591205	
	T0605597251K-1	Geotracker	T0605597251	
	T0605598080MW-1	Geotracker	T0605598080	
	05N04W15E001M	DWR	005N004W15E001M	Dom_Irr
Napa Valley Floor - MST	2800025	DPH	HAGAFEN CELLARS	
	2800548	DPH	SILVERADO PINES MOBILE HOME	
	2800554	DPH	GENE NORRIS PLAZA	
	2800564	DPH	SODA CANYON STORE	
	2800580	DPH	SYAR INDUSTRIES	
	2800717	DPH	NAPA PIPE REDEVELOPMENT PARTNERS	
	2800848	DPH	NVUSD: MT. GEORGE SCHOOL	
	2801039	DPH	SILVERADO HILL CELLARS	
	2801055	DPH	WILLIAM HILL WINERY	
	2801081	DPH	MT. GEORGE ESTATES	
	T0605500007BC-10	Geotracker	T0605500007	
	T0605500135UST-GW	Geotracker	T0605500135	
	T0605500138DM-1	Geotracker	T0605500138	
	T0605500140MW-1	Geotracker	T0605500140	
	T0605500166DW-1019	Geotracker	T0605500166	
	T10000000413MW-1	Geotracker	T10000000413	
Carneros	2800538	DPH	CARNEROS INN	
	2800847	DPH	NVUSD: CARNEROS SCHOOL	
	2801002	DPH	ETUDE WINES	

	WellID	SRC	SYS_NO	SITE_TYPE
	2801011	DPH	DOMAINE CARNEROS	
	2801089	DPH	DI ROSA ART PRESERVE	
	T0605517802MW-1	Geotracker	T0605517802	
	04N04W05C001M	DWR	004N004W05C001M	Unk_GW
	04N04W05D002M	DWR	004N004W05D002M	Dom
	04N04W04C002M	DWR	004N004W04C002M	Unk_GW
Jameson/American Canyon	T0605500012MW 1	Geotracker	T0605500012	
	T0605500077MW-1	Geotracker	T0605500077	
	T0605500240MW-4	Geotracker	T0605500240	
Napa River Marshes	2800530	DPH	MEYERS WATER CO.	
	2800531	DPH	MOORE S RESORT	
	2800592	DPH	NAPA VALLEY MARINA	
	2800811	DPH	ACACIA WINERY	
	2801080	DPH	MILTON ROAD WATER COMPANY	
	L10002804480DUP-1	Geotracker	L10002804480	
Angwin	2800527	DPH	LINDA FALLS TERRACE MUTUAL	
	2800528	DPH	LINDA VISTA MUTUAL WATER CO	
	2801936	DPH	O SHAUGHNESSY WINERY	
	2810001	DPH	HOWELL MOUNTAIN MUTUAL WATER COMPANY	
Berryessa	2800129	DPH	STERLING VINEYARDS	
	T0605500257061808	Geotracker	T0605500257	
	T0605500298MW-1	Geotracker	T0605500298	
	T0605500304	Geotracker	T0605500304	
	T0605500312EFF	Geotracker	T0605500312	
	T0605591908B-10	Geotracker	T0605591908	

	WellID	SRC	SYS_NO	SITE_TYPE
Central Interior Valleys	2800297	DPH	CATACULA LAKE WINERY	
	2800521	DPH	CIRCLE WATER DISTRICT	
	2800584	DPH	LAS POSADAS 4-H CAMP	
	2800593	DPH	R RANCH AT THE LAKE	
	T0605500279MW1	Geotracker	T0605500279	
	T0605592744MW-1	Geotracker	T0605592744	
Eastern Mountains	2800023	DPH	RUTHERFORD HILL MUTUAL WATER	
	2800024	DPH	DUCKHORN VINEYARDS	
	2800029	DPH	AUGUST BRIGGS WINERY	
	2800298	DPH	DBA SILVER ROSE CELLARS	
	2800525	DPH	LA TIERRA HEIGHTS MUTUAL	
	2800532	DPH	VAILIMA ESTATES MUTUAL WATER	
	2800561	DPH	FREEMARK ABBEY PROPERTIES	
	2800575	DPH	CALISTOGA RANCH	
	2800583	DPH	WELCOME GRANGE HALL	
	2800588	DPH	NAPA VALLEY COUNTRY CLUB	
	2800625	DPH	ST. HELENA HOSPITAL	
	2800719	DPH	MUND S MOBILE HOME PARK	
	2801009	DPH	CONN CREEK WINERY	
	2801014	DPH	RUDD WINES, INC., DBA RUDD	
	2801024	DPH	MUMM OF NAPA VALLEY	
	2801033	DPH	ROMBAUER VINEYARDS	
	2801035	DPH	ROUND HILL WINERY	
	2801043	DPH	SKYLINE PARK	
	2801056	DPH	Z D WINES	
	2801076	DPH	CAYMUS VINEYARDS	
	2801084	DPH	RUTHERFORD HILL WINERY	

	WellID	SRC	SYS_NO	SITE_TYPE
	2801086	DPH	STAGS LEAP WINERY	
	2803697	DPH	STELTZNER WINERY	
	2803879	DPH	JARVIS VINEYARD	
	2803907	DPH	MINER FAMILY WINERY	
Pope Valley	2800569	DPH	AETNA SPRINGS GOLF COURSE	
	2800970	DPH	HOWELL MTN SCHOOL	
	2810012	DPH	PACIFIC UNION COLLEGE	
	T0605593602021909	Geotracker	T0605593602	
	T10000000436MW-1	Geotracker	T10000000436	
Southern Interior Valleys	2800845	DPH	NVUSD: WOODEN VALLEY SCHOOL	
Western Mountains	2800301	DPH	LAIRD FAMILY ESTATE	
	2800613	DPH	LOKOYA REDWOODS	
	2800621	DPH	MAYACAMAS VINEYARDS	
	2801008	DPH	ARTESA VINEYARDS & WINERY	
	2801016	DPH	HESS WINERY	
	2801036	DPH	SCHRAMSBERG WINERY	
	2801054	DPH	WHITE SULPHUR SPRINGS RESORT	
	2810301	DPH	CSP-BOTHE-NAPA STATE PARK	
	2800032	DPH	TERRA VALENTINE	

APPENDIX C

Napa County Procedure for Measuring Groundwater Levels

NAPA COUNTY PROCEDURE FOR MEASURING

THE DEPTH TO WATER IN MONITORING AND PRODUCTION WELLS

Purpose

To obtain an accurate dated and timed measurement of the static depth to water in a well that can be converted into a water level elevation in reference to a commonly used reference datum (e.g., NAVD 1988). In this context, static means that the water level in the well is not influenced by pumping of the well. For comparability, measurements should be obtained according to an established schedule designed to capture times of both highest and lowest seasonal water level elevations. Also for comparability, measurements during a particular field campaign should be obtained consecutively and without delay within the shortest reasonable time.

Measurement Procedure

- If well is being pumped, do not measure (see below "Special Circumstances – Pumping Water Level on Arrival" for additional instructions).
- Turn on water level indicator signaling device and check battery by hitting the test button.
- Remove access plug or well cap from the well cover and lower probe (electric sounder) into the well.
- When probe hits water a loud "beep" will sound and signal light will turn red.
- Retract slightly until the tone stops.
- Slowly lower the probe until the tone sounds.
- Note depth measurement at rim (i.e., the surveyed reference point for water level readings) of well to the nearest 0.01 foot and rewind probe completely out of well.
- Remove excess water and lower probe once again into well and measure again.
- If difference is within ±0.02 foot of first measurement, record measurement.
- If difference is greater repeat the same procedure until three consecutive measurements are recorded within ± 0.02 foot.
- Rewind and remove probe from well and replace the access plug or well cap in the well cover.
- Clean and dry the measuring device/probe and continue to next well.

Special Circumstances

Oil Encountered in Well

If oil is detected in the well structure, the depth to the air-oil interface is measured. To obtain such a measurement, the electric sounder is used similar to the way chalked steel tapes were traditionally used for depth-to-water measurements.

1. Lower the cleaned probe well below the air-oil interface (e.g., 1 foot). Read and record the depth at the reference point (since this depth is chosen somewhat arbitrarily by the field technician, an even number can be chosen, e.g., 37.00 feet). This measurement is the length of cable lowered into the well and corresponds to a line that the oil leaves on the probe or cable (i.e., the oil inundation line). Above this line, smudges of oil may appear on the cable. Below this line, the cable/probe is completely covered with oil. If the probe is lowered too far, completely penetrates the oil, and is far submerged in the water below the oil, parts of the probe/cable below the oil inundation line may also appear smudgy.
2. Retrieve probe, identify and record the oil inundation line on the cable (e.g., 2.72 feet). This measurement does not reflect the thickness of the oil. It reflects the length of the cable below the air-oil interface.
3. Compute the depth to oil by subtracting the length of line below the air-oil interface from the corresponding measurement at the reference point: Depth to oil = 37.00 feet – 2.72 feet = 34.28 feet.

Since oil has a slightly smaller density than water, a depth-to-oil measurement will always be smaller than a corresponding depth-to-water measurement in the same well if oil were not present. Depth-to-oil measurements yield a reasonable approximation to depth-to-water measurements unless the oil thickness is great. For each foot of oil in the well casing, the depth-to-oil measurement will be approximately 0.12 foot smaller than a corresponding depth-to-water measurement if oil were not present.

Pumping Water Level on Arrival

If well is being pumped, do not measure. Return later when the water level has stabilized. Using past field notes, the field technician will use his/her experience to determine the appropriate duration necessary for static measurements. Upon returning to the well site (at a location where pumping was previously noted on the same day), the technician will measure the water level. The technician will have available historical water level data to determine whether the measurement is consistent with past measurements. If the initial measurement appears anomalous, the technician will measure water levels every 10 minutes over a period of 30 minutes. If measurements vary significantly from past measurements (taking into account seasonal variations), the technician will note the circumstances (i.e., the date and time when the well was first visited, total time it was pumping (if known), when it was shutoff, when the technician returned, and subsequent water level measurements [on the same day, or as the case may be based on experience, the day immediately following]). Subsequent consideration of pumping effects at a site-specific well location will be addressed as necessary.

Recordation

1. Name of field technician
2. Unique identification of well
3. Weather and site conditions (e.g., clear, sunny, strong north wind, intense dust blowing over wellhead from nearby plowed field; dry ground, easy access)
4. Condition of well structure (e.g., well cap cracked – replaced with new one; wasp hive between well casing and well housing; no action, discuss with project manager)
5. Time and date of depth-to-water reading
6. Any other pertinent comments (e.g., sounder hangs up at 33 feet, thus no measurement; or: fifth measurement of ~55.68 feet in a row…residual water in end cap?; or: oil in well…measurement is depth to oil; or: intense sulfur odor upon opening well cap; or: nearby (west ~100 feet) irrigation well pumping)

CALIFORNIA STATEWIDE GROUNDWATER ELEVATION MONITORING
(CASGEM)

STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES

GROUND WATER LEVEL MEASUREMENTS

Monitoring Entity: Napa County
Monitoring Period:_____
Measuring Agency Number: 3983
Measured By:_____

STATE WELL NUMBER	COUNTY WELL ID	MSRMNT DATE	R.P. ELEVATION (NAVD88 ft)	DIST. R.P. TO WATER	METHOD OF WATER DEPTH MSRMNT	MSRMNT QUALITY CODES[1]	MSRMNT TIME	COMMENTS

1 **MEASUREMENT QUALITY CODES:**

- If **no** measurement is taken, a specified "no measurement" code, must be recorded.
  0. Discontinued 1. Pumping 2. Pumphouse locked 3. Tape hung up 4. Can't get tape in casing 5. Unable to locate well 6. Well destroyed 7. Special 8. Casing leaking or wet 9. Temporarily inaccessible D. Dry well F. Flowing well
- If the quality of a measurement is **uncertain**, a "questionable measurement" code can be recorded.
  0. Caved or deepened 1. Pumping 2. Nearby pump operating 3. Casing leaking or wet 4. Pumped recently 5. Air or pressure gauge measurement 6. Other 7. Recharge operation at nearby well 8. Oil in casing 9. Acoustical sounder measurement

APPENDIX D

Example Field Sheet for Groundwater Quality Sampling

FIELD PURGE DATA
Monitoring Wells

Client: _____ Date: _____

Project: _____ Project No.: _____

Well ID: _____ Measured By: _____

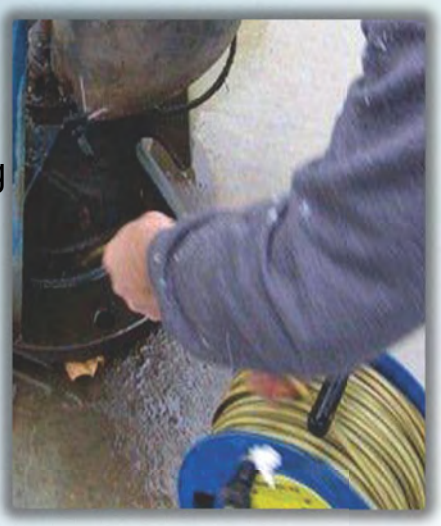
TOTAL WELL DEPTH (ft)		CASING DIAMETER (in)		STICKUP (ft)		STATIC WATER LEVEL (ft)	
		PVC / Steel					
STANDING WATER COLUMN (ft)	x	0.16 (for 2" casing); 0.37 (for 3" casing) 0.65 (for 4" casing); 1.0 (for 5" casing) 1.47 (for 6" casing); 2.61 (for 8" casing) 4.08 (for 10" casing); 5.88 (for 12" casing) 10.45 (for 16" casing); 16.32 (for 20" casing)	=	WET CASING VOLUME, Vc (gal)		3 Vc (gal)	

Clock Time	Pumping Time (min)	Pump Rate (Hz)	Flow Rate (gpm)	Cumulative Flow (gals)	DTW (ft)	Temp (°F / °C)	pH	Sp. Cond. at 25°C (µs/cm)	Turbidity (NTU)	DO (mg/L)	ORP (milliVolt)	Observations (redox, color, odor, etc.)

Water Sample Collection (number of bottles and sample I.D.)

APPENDIX 5B

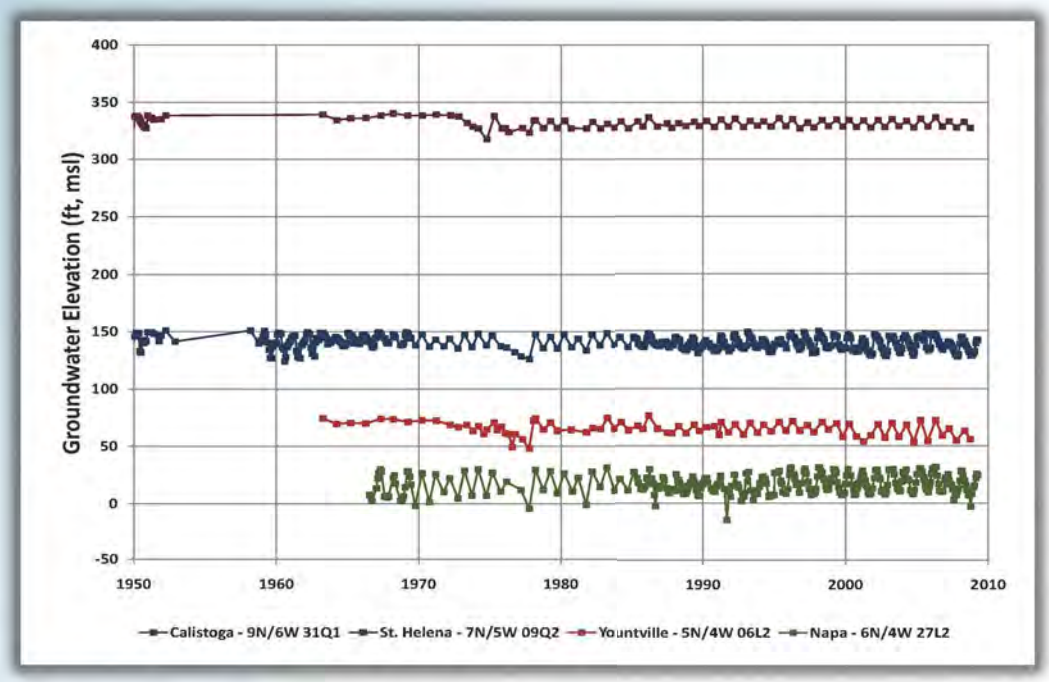
Napa County California Statewide Groundwater Elevation Monitoring (CASGEM) Network Plan (2014)



Napa County
California Statewide Groundwater Elevation Monitoring (CASGEM) Network Plan

Originally Prepared in
September 2011

Updated in
August 2014



LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Napa County
California Statewide Groundwater Elevation Monitoring (CASGEM) Network Plan

Originally Prepared

September 2011

Updated

August 2014

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Table of Contents

1.0 INTRODUCTION

1.1 CASGEM Goal

In November 2009, Senate Bill SBX7-6 mandated that the groundwater elevations in all basins and subbasins in California be regularly and systematically monitored with the goal of demonstrating seasonal and long-term trends in groundwater elevations. In accordance with the mandate, the California Department of Water Resources (DWR) developed the California Statewide Groundwater Elevation Monitoring (CASGEM) program. DWR is facilitating the statewide program which began with the opportunity for local entities to apply to DWR to assume the function of regularly and systematically collecting and reporting groundwater level data for the above purpose. These entities are referred to as Monitoring Entities. The legislature added a key aspect to SBX7-6 which was to make certain elements of the groundwater level information available to the public.

1.2 CASGEM Program Complements Other Monitoring Programs

Wells designated for inclusion in the CASGEM program are for purposes of measuring groundwater levels on a semi-annual or more frequent basis that are representative of groundwater conditions in the state's groundwater basins and subbasins. The wells selected by a designated Monitoring Entity may be a subset of other wells monitored by that entity and need not be inclusive of the designated entity's entire monitoring network. Thus, the CASGEM program complements other pre-existing programs that have been developed throughout California by water districts, agencies, municipalities, counties, and others for purposes of understanding, managing, and sustaining groundwater resources.

In 2009, Napa County implemented a Comprehensive Groundwater Monitoring Program to meet identified action items in Napa County's 2008 General Plan update (Napa County, 2008). This program covers the continuation and expansion of countywide groundwater level monitoring efforts (including many basins, subbasins and/or subareas throughout the county) for the purpose of understanding groundwater conditions (i.e., seasonal and long-term groundwater level trends and also quality trends) and availability to enable integrated water resources planning and dissemination of water resources information. Napa County's combined efforts through the Comprehensive Groundwater Monitoring Program along with the related AB 303 Public Outreach Project (CCP, 2010) and the efforts of the Watershed Information Center & Conservancy (WICC) of Napa County (www.napawatersheds.org) create a foundation for the County's continued efforts to increase public outreach and participation. An informed and engaged public enables support of planned water resources projects and programs proposed by the County and others.

1.3 Napa County Monitoring Entity

On December 29, 2010, the County of Napa applied to DWR to become the countywide Monitoring Entity which would designate wells as appropriate for monitoring and reporting groundwater elevations for purposes of the CASGEM program. Following confirmation of DWR's acceptance of the County as the Monitoring Entity, the County proceeded to identify the

wells to be included in the monitoring program network and to prepare this CASGEM Network Plan (Plan) as required by DWR.

This Plan contains the recommended components outlined by DWR, including a summary of the geology and groundwater resources in Napa County. This Plan also identifies the planned CASGEM well network, the rationale for the selection of the wells, the field methods, and the monitoring schedule.

1.4 County Outreach

In August 2011[1], the County sent a letter to other entities in the county informing them of the County's role as the CASGEM Monitoring Entity, efforts underway to prepare a CASGEM Plan, and planned groundwater elevation data submittal by the January 2012 deadline. The County explained the process underway to evaluate the suitability of the wells that have historically been monitored by the County for inclusion in the CASGEM program/plan. The County also explained to other entities that it is seeking property owner interest and participation in the CASGEM program from those owners whose wells may be suitable and have historically been monitored by the County. Additional outreach was conducted from 2012 to present through public workshops and meetings with industry, environmental, and community groups.

2.0 NAPA COUNTY AREA

2.1 DWR Basins/Subbasins and County Subareas

The CASGEM program largely refers to DWR's depiction of the major groundwater basins and subbasins in and around Napa County, including the Napa-Sonoma Valley (which in Napa County includes the Napa Valley and Napa-Sonoma Lowlands Subbasins), Berryessa Valley, Pope Valley, and a small part of the Suisun-Fairfield Valley Groundwater Basins (**Figure 1**). These basins and subbasins are generally defined based on boundaries to groundwater flow and the presence of water-bearing geologic units. The groundwater basins defined by DWR are not confined within county boundaries, and DWR-designated "basin" or "subbasin" designations do not cover all of Napa County.

The Suisun-Fairfield Valley Basin and the Napa-Sonoma Lowlands Subbasin are two examples of basins that do not conform to county boundaries, and they are also basins with a DWR low priority designation.[2] While these two basins have low groundwater utilization and less extensive monitoring than other basins, they are situated adjacent to the bay and delta water ways and are important areas to monitor for protection against saltwater intrusion. The Suisun-Fairfield Valley Basin, which is mostly in Solano County and has only a very small area (less than 0.3% of the total basin area) in Napa County, is being monitored in its entirety by Solano County Water Agency as the CASGEM Monitoring Entity for Solano County. The monitoring of

[1] The original Napa County CASGEM Network Plan was submitted to DWR in September 2011. This Plan provides updated information especially as related to two low priority groundwater basins as discussed in Section 5.
[2] As part of the CASGEM Program, DWR has developed the Basin Prioritization process. The California Water Code (§10933 and §12924) requires DWR to prioritize California's groundwater basins and subbasins statewide. As such, DWR developed the CASGEM Groundwater Basin Prioritization Process. Details are available at http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm.

Napa-Sonoma Lowlands Subbasin, whose area is shared with Solano County in more equitable portions (63% in Napa County, 37% in Solano County), is anticipated to have monitoring that is coordinated between the two respective Monitoring Entities in the future. Currently, all monitoring is within the Napa County portion of the subbasin; in the future, monitoring in this subbasin will expand as necessary to ensure representative coverage and as coordinated between the two Monitoring Entities.

Groundwater conditions outside of the DWR-designated areas are also very important in Napa County. An example of such an area is the Milliken-Sarco-Tulucay (MST) area, a locally identified groundwater deficient area. For purposes of the County's CASGEM Plan, and prior groundwater studies, the county has been subdivided into a series of subareas (**Figure 2**). These subareas were delineated based on the main watersheds, groundwater basins, and the County's planning areas. These include the Knoxville, Livermore Ranch, Pope Valley, Berryessa, Angwin, Central Interior Valleys, Eastern Mountains, Southern Interior Valleys, Jameson/American Canyon, Napa River Marshes, Carneros, and Western Mountains Subareas and five Napa Valley Floor Subareas (i.e., Calistoga, St. Helena, Yountville, Napa, and MST).

2.2 Geology and Groundwater Resources

The geology of Napa County can be divided into three broad geologic units based on their ages and geologic nature. These units are: 1) Mesozoic Basement Rocks (pre-65 million years (my)), which underlie all of Napa County, but they are primarily exposed in the Eastern County area and the Western Mountains Subarea, 2) Older Cenozoic Volcanic and Sedimentary Deposits (65 my to 2.5 my), including Tertiary Sonoma Volcanics (Miocene and Pliocene; 10 my to 2.5 my) which are found throughout the county, especially in the mountains surrounding Napa Valley, and 3) Younger Cenozoic Volcanic and Sedimentary Deposits (post 2.6 my to present), including the Quaternary alluvium of the Valley Floor. The two primary water-bearing units in the county are the tuffaceous member of the Sonoma Volcanics and the Quaternary alluvium.

Outside of the Napa Valley Floor, percolation of surface water appears to be the primary source of recharge. The rate of recharge within areas such as the MST Subarea has been shown to be significantly higher where streams and tributaries cross highly permeable outcrops (e.g., the tuffaceous member of the Sonoma Volcanics or shallow alluvium). Direct infiltration of precipitation is a major component of recharge in the main Napa Valley. Recharge throughout much of the county is generally limited by underlying shallow bedrock of low permeability. An additional component of groundwater recharge is deep percolation through fractured rock and fault zones. This type of recharge can be very difficult to quantify due to the highly variable size and distribution of faults, fractures, and joints in a given area.

3.0 PREVIOUS GROUNDWATER STUDIES

3.1 Napa County's Comprehensive Groundwater Monitoring Program

Napa County's Comprehensive Groundwater Monitoring Program involved many tasks that led to the preparation of five technical memorandums and a report on *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011). A subsequent report, *Updated Hydrogeologic Conceptualization and Characterization of Conditions* (LSCE, 2013a)

was completed with the assistance of the Napa County Groundwater Resources Advisory Committee (GRAC) in 2013. Additionally, the County has led the development of an updated *Napa County Groundwater Monitoring Plan 2013* (LSCE, 2013b). This Plan extends previous groundwater monitoring efforts, identifies areas where additional monitoring is needed to improve the understanding of groundwater resources and availability, summarizes groundwater monitoring priorities, and provides recommendations for addressing those priorities. These reports document existing knowledge of countywide groundwater conditions and establish a framework for the monitoring and reporting of groundwater levels and groundwater quality on a periodic basis. These reports and other related documents can be found at the County's groundwater webpage: http://www.countyofnapa.org/bos/grac.

3.2 Current Countywide Groundwater Level Monitoring

As part of the County's Comprehensive Groundwater Monitoring Program, groundwater level data were examined and groundwater data gaps identified by county subareas (LSCE, 2011 and 2013b). Historical groundwater level measurements have been recorded at a total of 676 wells (173 wells/sites) through at least 2005. Currently[3], 89 wells are monitored for water levels.

There are many areas in the county where further efforts to establish groundwater monitoring, using existing or new monitoring facilities, will improve the understanding of groundwater conditions and availability. Primary objectives for addressing groundwater level monitoring include:

- Evaluate groundwater levels in the various county subareas to describe the occurrence and movement of groundwater and identify vertical hydraulic head differences in the aquifer system;
- Detect the occurrence of, and factors attributable to, natural (e.g., direct infiltration of precipitation, surface water seepage to groundwater, groundwater discharge to streams) or induced (e.g., pumping, purposeful recharge operations) factors that affect groundwater conditions and trends;
- Identify where data gaps occur and provide infill, replacement, and/or project-specific monitoring (e.g., such as may occur for planned projects or expansion of existing projects) as needed;
- Develop and/or refine water budgets for key subareas, including recharge, extraction, and change in storage in the aquifer(s); and
- Employ methods to better estimate groundwater basin conditions, assess local current and future water supply availability and reliability, and update analyses as additional data become available.

Napa County has been monitoring and reporting groundwater level measurements to DWR for many years. Reported wells are primarily located in the five subareas of the Napa Valley Floor (i.e., Calistoga, MST, Napa, St. Helena, and Yountville Subareas). As of 2011, a total of 39 wells were being recurrently measured by the County semi-annually in the spring and fall. Of those 39 wells, level measurements in 26 wells were being reported to DWR for inclusion in DWR's

[3] "Current" refers to monitored sites with wells measured for levels with a period of record extending to 2011 or later.

Water Data Library, and the remaining 13 wells are measured for County information. Since 2011, the County has continued these monitoring activities while conducting outreach to additional well owners in under-represented areas of the County. The updated Groundwater Monitoring Plan 2013 further prioritizes the designated subareas and identifies groundwater/surface water monitoring sites and 18 areas of interest to be added to the groundwater level monitoring network. Construction of 5 monitoring wells for evaluating surface water/groundwater interaction is planned to begin in early Fall 2014.

3.3 Current Groundwater Conditions

Groundwater level data are primarily available for the subareas in the Napa Valley Floor. Most of these data are not able to be correlated to specific aquifer units due to a lack of associated well construction and lithologic log information. As a result, evaluation of groundwater levels and conditions specific to individual aquifer zones is limited at this time.

Based on available groundwater level data, levels in the county are generally stable, with the exception of the MST Subarea. Groundwater in the Napa Valley Floor generally flows toward the axis of the valley and south when not influenced by local pumping depressions. The MST Subarea, however, has shown significant declines in groundwater levels, especially in the central portion of the subarea. Contemporaneous changes in water level trends are possible to discern throughout the MST. The variation and timing of groundwater level declines and trends in the north, central, and southern areas of the MST that have historically occurred may be attributable to increased pumping and/or variations in geologic conditions. Wells in the immediate vicinity of the MST Subarea may also be vulnerable to these variations as seen from limited data in the eastern portion of the Napa Valley Floor-Napa (NVF-Napa) Subarea and the southwestern part of the Eastern Mountains Subarea. Most wells elsewhere in the Napa Valley Floor with a sufficient record indicate that groundwater levels are more affected by climatic conditions, are within historic levels, and seem to recover from dry periods during subsequent wet or normal periods.

Groundwater level conditions outside of the Napa Valley Floor are much less known. Lithology, terrain, and monitoring well distribution in areas outside of the Napa Valley Floor combine to make it difficult to characterize groundwater resources in other subareas of the county. Subareas south of the Valley have very limited water level data, making it difficult to impossible to assess any potential for historical or current saltwater intrusion from San Pablo Bay. Subareas east and west of the Valley Floor have limited data or are lacking groundwater level data entirely (as seen in Livermore Ranch, Southern Interior Valleys, and Western Mountains Subareas). Where data are available, most records are short, spanning a few years at most. Though the data are limited and spatially distributed, it appears that groundwater level conditions in these areas are stable. Additional details on historical monitoring, groundwater data availability, the occurrence of groundwater, and groundwater level trends is reported in *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011), *Updated Hydrogeologic Conceptualization and Characterization of Conditions* (LSCE, 2013a), and *Napa County Groundwater Monitoring Plan 2013* (LSCE, 2013b). These reports document existing knowledge of countywide groundwater conditions, establish a framework for the monitoring and reporting of groundwater levels and quality, and provide an update on current groundwater monitoring efforts. These reports and other related documents can be found at the County's

groundwater webpage: http://www.countyofnapa.org/bos/grac. Immediate plans in 2014/2015 involve the preparation of the first in an ongoing series of Annual Groundwater Conditions Reports/Updates.

4.0 CASGEM MONITORING NETWORK AND PROGRAM

4.1 DWR Basins/Subbasins and County Subareas for CASGEM Program

While the focus of DWR's CASGEM program is largely on DWR-designated groundwater basins and subbasins, groundwater conditions outside of these DWR-designated areas are also very important in Napa County. One such example in Napa County is the NVF-MST Subarea. As the County's Comprehensive Groundwater Monitoring Program and also the CASGEM program evolve, the County has continued to seek resources and property owner consent to have representative groundwater monitoring in all the DWR-designated basins and subbasins and most if not all county subareas.

4.2 Napa County Public Outreach

Napa County has been conducting groundwater monitoring for many years. Since the CASGEM program includes public disclosure of information in addition to measured water levels, the County conducted public outreach to property owners to confirm their interest in participating in the CASGEM program. In July 2011, the County sent letters to 25 property owners whose wells have been historically monitored by the County. In August 2011, the County sent reminder letters to those owners who had not responded to the County's initial inquiry about their interest in participating in the program, and also telephoned property owners. Additional letters about CASGEM participation were also sent in August 2011 to 6 property owners whose wells have been monitored by DWR for water quality, water levels, or both. As a result, the County received responses from thirteen owners interested in participating (for a total of 14 wells) and 4 owners not interested in participating in the CASGEM program. Monitoring of all wells previously monitored by the County will continue as before; however, only groundwater level data collected from these 14 wells will be reported to DWR through the CASGEM online submittal system. One of the 14 wells has been historically monitored by DWR only for water quality, so the monitoring of this well will be coordinated with DWR so that water quality and water elevation will be conducted concurrently. The remainder of the wells that are not part of the CASGEM program will continue to be monitored by the County and a subset reported to DWR via the CASGEM online system (as volunteer wells) for display and use in the Water Data Library. (Note: Also see Section 5.0 - CASGEM Monitoring Network – Future, for additional public outreach and well monitoring network update information).

4.3 Selected CASGEM Wells

As described below, further public outreach and evaluation of wells suitable for the County's Comprehensive Groundwater Monitoring Program and the CASGEM program are being conducted. The County plans to expand its countywide groundwater monitoring program, including the CASGEM well network as public awareness expands and resources become available. The CASGEM well network is described in detail below along with other efforts to continue to expand the countywide monitoring program.

Napa County CASGEM Network

During the initial CASGEM monitoring year (beginning 2011), the County continued to monitor 14 wells that had already been part of the group of wells where groundwater levels are measured by the County and reported to DWR semi-annually, or are measured directly by DWR. The current 2014 CASGEM network wells are located primarily on the Napa Valley Floor, Carneros, and in the MST Subarea (**Figure 3**). Some of these wells do not have sufficient construction details to define which portion of the aquifer system is represented by measured water levels Additional data gathering and surveying will be performed, and such information will be provided in future annual reports as it becomes available. Depending on the results of the County's evaluation, future actions may include removal and replacement of CASGEM wells with wells that are more representative of local groundwater conditions to better meet the objectives of the CASGEM program and also overall objectives of the County's Comprehensive Groundwater Monitoring Program. The Napa County CASGEM network meets the objectives for:

- Providing representative groundwater conditions in Napa County groundwater basins, subbasins, and/or county subareas; and
- Providing systematic groundwater elevations for purposes of demonstrating seasonal and long-term trends.

For a detailed summary of the County's CASGEM network well information[4], see **Appendix A**.

4.4 Field Methods

Napa County has documented field procedures for the collection of groundwater level measurements which were updated as part of the County's Comprehensive Groundwater Monitoring Program (**Appendix B**; LSCE, 2010a). An example form for recording water level measurements is also included here. The County will use these procedures for the CASGEM program (CASGEM wells) as well as continued monitoring of wells where water level data are submitted to DWR semi-annually for inclusion in DWR's Water Data Library (Volunteer Wells), and the monitoring of other wells measured for internal County-only information.

4.5 Monitoring Schedule

Historically, the County has measured the newly designated CASGEM wells semi-annually in the spring (April) and fall (October) of each year. Historical hydrographs show that these measurement periods generally correspond to the seasonal high and low groundwater elevations observed in their respective county subareas. The County will continue to measure the CASGEM network wells semi-annually during similar periods.

[4] Figure 3 and Appendix A provide details for the original CASGEM program. The County's public outreach program has resulted in additionally volunteered wells that are being considered. The updated CASGEM network will be described in the County's Annual Groundwater Conditions Report and CASGEM Update (to be prepared in winter 2014/2015).

4.6 Groundwater Elevation Data Management and CASGEM Data Submittal

As part of the Comprehensive Groundwater Monitoring Program, a Data Management System (DMS) was developed for the County to establish a centralized repository for recording and archiving countywide well construction data (for monitored wells), cataloging historical groundwater level and quality measurements, and developing procedures for analyzing data on a programmatic basis. Groundwater data collected by the County (including data collected as part of the CASGEM program and other County programs) will be input into the DMS in a systematic way through a centralized person or department to ensure data accuracy and consistency. It is expected that there will be regular updates from internal County sources and external agencies of new data for new and existing wells/sites tracked in the DMS. Consistent quality control of the data and data entry are described in the documentation for the DMS (LSCE, 2010b).

Per DWR's CASGEM program reporting requirements, the following information related to each of the designated wells monitored will be submitted online at the end of each calendar year:

- Well identification number (DWR state well number in online format)
- Measurement dates
- Reference point elevation of the well (feet) using NAVD88 vertical datum
- Elevation of land surface datum at the well (feet) using NAVD88 vertical datum
- Depth to water below reference point (feet) (unless no measurement was taken)
- Method of measuring water depth
- Measurement quality codes[5]
- Measuring agency identification (Napa County as the Monitoring Entity)
- Measurement time (PST/PDT with military time/24 hour format)
- Comments about measurement, if applicable

5.0 CASGEM MONITORING NETWORK – FUTURE

In addition to the CASGEM well network described herein, the County is currently exploring the availability of a monitoring well in the Pope Valley Groundwater Basin[6]. Public outreach is underway at this time through community organizations and other contacts. The Berryessa Valley Groundwater Basin has a very low DWR priority and extremely small utilization of groundwater[7]. Per discussions with DWR, outreach will continue but no monitoring is planned in this groundwater basin at this time. The County has submitted detailed information to DWR to support consideration of the removal of this basin through a Bulletin 118 update or other appropriate process. Additional wells in the seven County subareas (including the NVF-Calistoga, NVF-MST, NVF-Napa, NVF-St. Helena, NVF-Yountville, Carneros, and Pope Valley Subareas) are also being added as a part of the County's Comprehensive Groundwater

[5] Measurement quality codes examples include: 1) If no measurement is taken, a specified "no measurement" code, must be recorded. 2) If the quality of a measurement is uncertain, a "questionable measurement" code can be recorded. Standard codes will be provided by DWR's online system.

[6] DWR Overall Basin Ranking Score is "0.0"; the very low priority basin ranking range is 0-5.4. http://www.water.ca.gov/groundwater/casgem/pdfs/basin_prioritization/NCRO%2074.pdf

[7] DWR Overall Basin Ranking Score is "0.0"; the very low priority basin ranking range is 0-5.4. http://www.water.ca.gov/groundwater/casgem/pdfs/basin_prioritization/NCRO%2062.pdf

Monitoring Program and Updated Groundwater Monitoring Plan 2013. The Napa Valley Floor subareas are given a higher priority based on factors of current and/or projected land and water use. Additional wells in these subareas are of interest for (LSCE, 2013b):

- Improving horizontal and/or vertical spatial distribution of data;
- Identifying appropriate monitoring sites to evaluate surface water-groundwater recharge/discharge mechanisms; and
- Establishing additional basic data needed to accomplish groundwater level monitoring objectives as described above in **Section 3.2**.

Further examination of the suitability of existing wells for groundwater monitoring (including their location and construction and relevance to meet County and/or CASGEM monitoring objectives) is necessary to determine if any existing wells would be suitable for ongoing evaluation of groundwater conditions. If existing private wells are considered, approval from the property owners to participate in the CASGEM program would be sought. Additional wells may be added to provide better spatial and/or vertical distribution of monitored locations within County subareas and to enhance the understanding of localized groundwater conditions and availability.

On June 28, 2011, the County Board of Supervisors adopted a resolution establishing a Groundwater Resources Advisory Committee (GRAC). Two of the tasks assigned to the GRAC included: 1) assisting with the synthesis of the existing groundwater information and identifying critical data needs, and 2) providing input on the furtherance of the ongoing countywide groundwater monitoring program. Input from this committee was coordinated to optimize additional groundwater monitoring locations that serve to meet the objectives of the County's Comprehensive Groundwater Monitoring Program and the CASGEM monitoring program.

The first meeting of the GRAC was held in October 2011. Over the past 2 ½ years, the County has conducted additional public outreach with the assistance of the GRAC to inform more private well owners of the value of understanding the groundwater resources in the County and to encourage their participation in the Comprehensive Groundwater Monitoring Program and/or CASGEM program. This effort has resulted in more than 40 additional volunteered wells, with a number of those being considered for the CASGEM program. Wells will continue to be included based upon the availability of well logs and other information that will contribute to meeting the objectives of the County's Comprehensive Groundwater Monitoring Program and the CASGEM program.

5.1 Address Data Gaps

Eight of the twenty proposed CASGEM wells have incomplete construction information due to the lack of either well depth or screened interval depths (see **Appendix A**). The County is actively pursuing this missing construction information through searches of historical records, additional meetings with well owners, and other investigative methods. Due to the limitation of construction details for these eight wells there will be a temporary gap of detailed aquifer information in the central and southern portion of the Napa Valley Subbasin that will be corrected once the construction documentation is complete, or as other wells are recruited into the monitoring program and added to the County's CASGEM network. The County is actively

pursuing additional CASGEM wells in all identified DWR basins and in other areas of local concern through on-going outreach efforts and grant applications to fund new monitoring well construction as described herein.

5.2 Reporting

The County, in accordance with the GRAC's recommendation, intends to prepare an annual report summarizing the results and findings of the current CASGEM program. Each annual report will describe any changes to the current monitoring network and program, including recommended additions to the CASGEM program network to meet the County's stated objectives for its Comprehensive Groundwater Monitoring Program. The first Annual Groundwater Conditions Report and CASGEM Update will be prepared in Winter 2014/2015.

6.0 REFERENCES

Center for Collaborative Policy at California State University Sacramento. 2010. Assessment of the feasibility of a collaborative groundwater data gathering effort in Napa County, California.

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LSCE. 2010b. Task 1, Napa County data management system. Technical Memorandum.

LSCE. 2011. Napa County groundwater conditions and groundwater monitoring recommendations. Task 4, Report.

LSCE. 2013a. Updated Hydrogeologic Conceptualization and Characterization of Conditions January 2013.

LSCE. 2013b. Napa County Groundwater Monitoring Plan. January 2013.

Napa County. 2008. Napa County general plan. (Amended June 23, 2009.)

Napa County Web Site. 2014.

FIGURES

COLUSA
COUNTY

LAKE
COUNTY

YOLO
COUNTY

SONOMA
COUNTY

SOLANO
COUNTY

N

Legend

DWR Groundwater Basin, Subbasin

- Napa-Sonoma Valley Basin, Napa Valley Subbasin
- Napa-Sonoma Valley Basin, Napa-Sonoma Lowlands Subbasin
- Berryessa Valley Basin
- Pope Valley Basin
- Suisun-Fairfield Valley Basin
- County Boundary

0 4 8 Miles

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CONSULTING ENGINEERS

Figure 1
Napa County Groundwater Basins
Napa County, CA

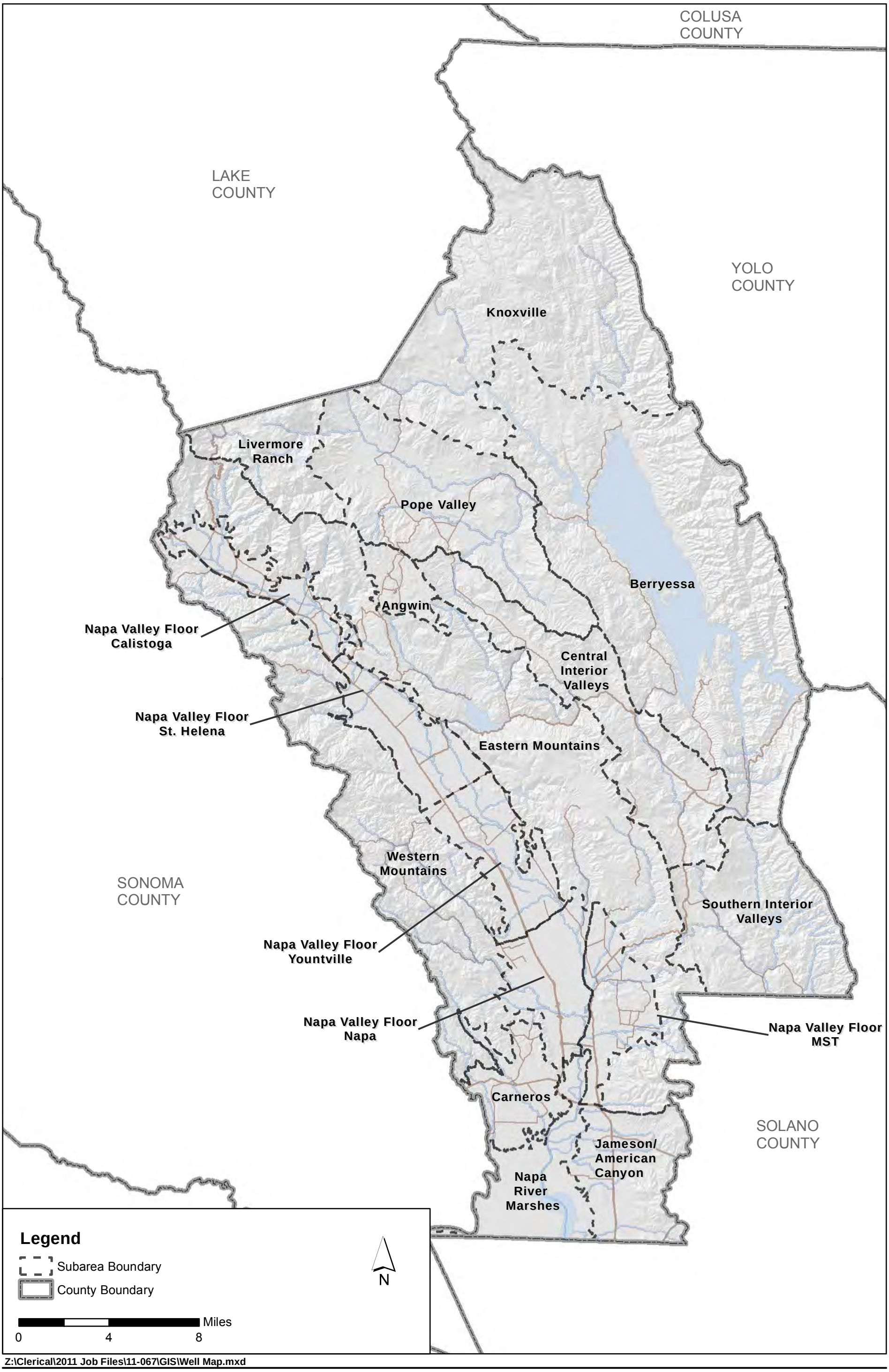

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Figure 2
Napa County Subareas
Napa County, CA

COLUSA COUNTY

LAKE COUNTY

YOLO COUNTY

SONOMA COUNTY

SOLANO COUNTY

Knoxville

Livermore Ranch

Pope Valley

Berryessa

202
Angwin

208

Napa Valley Floor Calistoga

169

Central Interior Valleys

Eastern Mountains

Napa Valley Floor St. Helena

7N/5W-16L1 (131)

7N/5W-16N2 (138)

Western Mountains

Napa Valley Floor Yountville

Napa Valley Floor MST

Napa Valley Floor Napa

180

179

Southern Interior Valleys

182

191

6N/4W-27N1 (136)

5N/3W-06A1 (92)

5N/3W-06M1 (74)

5N/3W-06B2 (91)

5N/4W-13H1 (137)

Carneros

195

5N/4W-31R1 (154)

4N/4W-5A1 (153)

201

200

4N/4W-6M1 (155)

Napa River Marshes

Jameson/ American Canyon

Legend

- Well in CASGEM Program

N

DWR Groundwater Basin, Subbasin

- Napa-Sonoma Valley Basin, Napa Valley Subbasin
- Napa-Sonoma Valley Basin, Napa-Sonoma Lowlands Subbasin
- Berryessa Valley Basin
- Pope Valley Basin
- Suisun-Fairfield Valley
- Subarea Boundary
- County Boundary

Miles

0 4 8

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Figure 3
Well Location Map for CASGEM Program
Napa County, CA

APPENDIX A

Napa County CASGEM Network Well Information

Appendix A
Napa County CASGEM Network Well Information

General Well Information									Well Location					Well Elevation						Well Construction				
Napa County Subarea	DWR GW Basin Number[1]	State Well Number (County Well ID)	Water Level Period of Record	Msmt Frequency	# of Msmts	Aquifer Designation	Well Use	Operational Status	Latitude	Longitude	Coordinate Method	Horizontal Datum	Coordinate Accuracy (feet)	RPE Description	Reference Point Elevation (feet)	Ground Surface Elevation (feet)	Elevation Method	Vertical Datum	Elevation Accuracy (feet)	Well Completion Report Number	Date	Well Depth (feet)	Well Completion Type	Screened Interval (feet)
NVF-MST	--	5N/3W-06B2 (91)	1992-2014	SA	55	SV	Dom	Active	38.308600	122.234300	USGS Quad map approx.	NAD83	150	top of casing access NW	282.2	283	USGS Quad approx.	NAVD88	10	119632	Aug-1986	415	Single	315-415
NVF-MST	--	5N/3W-06A1 (92)	1999-2014	SA	18842	Qal/SV?	Dom	Active	38.316065	122.223740	GPS	NAD83	10	top of casing access East	298.7	298	GPS	NAVD88	5	Unk	1992	368	Single	148-368
NVF-MST	--	5N/3W-06M1 (74)	1999-2014	SA	14140	Qal/SV?	Dom	Active	38.305707	122.244377	GPS	NAD83	10	top of casing access South	133.2	132	GPS	NAVD88	5	Unk	Aug-1988	300	Single	100-120, 180-300
NVF-MST	--	5N/4W-13H1 (137)	1979-2014	SA	66	Qal/SV?	Irr	Active	38.283400	122.248300	USGS Quad map approx.	NAD83	150	top of casing access North	135.9	135	USGS Quad approx.	NAVD88	10	Unk	Jul-1962	364	Single	Unk
NVF-Napa	2-2.01	6N/4W-27N1 (136)	1979-2014	SA	70	Qal?	Dom/Irr	Active	38.331300	122.299400	USGS Quad map approx.	NAD83	150	top of casing access East	53.5	53	USGS Quad approx.	NAVD88	10	Unk	1962	120	Single	Unk
NVF-St. Helena	2-2.01	7N/5W-16L1 (131)	1963-2014	SA	102	Qal	Dom	Active	38.455700	122.422500	USGS Quad map approx.	NAD83	150	top of casing hole as elec. N	174.8	174	USGS Quad approx.	NAVD88	10	28434	Jul-1939	221	Single	7 lengths, depths unk
NVF-St. Helena	2-2.01	7N/5W-16N2 (138)	1949-2014	SA	104	Qal/SV?	Dom/Irr	Active	38.451800	122.429900	USGS Quad map approx.	NAD83	150	top of casing access South	196.1	196	USGS Quad approx.	NAVD88	10	Unk	1923 approx	321	Single	Unk
Carneros	2-2.03	4N/4W-5A1 (153)	2012-2014	SA	5	QTh	Dom/Stk	Active	38.228926	122.321256	USGS Quad map approx.	NAD83	150	top of casing	47.65	47	GPS	NAVD88	10	121508	May-1978	200	Single	60-200
Carneros	2-2.03	5N/4W-31R1 (154)	2012-2014	SA	5	QTh?	Dom/Irr	Active	38.231151	122.339426	USGS Quad map approx.	NAD83	150	top of casing	98.3	96.65	GPS	NAVD88	10	370535	Aug-1990	300	Single	60-295
Carneros	2-2.03	4N/4W-6M1 (155)	2012-2014	SA	5	QTh?	Dom	Active	38.219695	122.352540	USGS Quad map approx.	NAD83	150	top of casing	25.3	23.8	GPS	NAVD88	10	770075	Aug-2003	220	Single	80-160, 200-220
NVF-St. Helena	2-2.01	unk (169)	2014	SA	1	TBD	Dom	Active	38.499996	122.474434	GPS	NAD83	150	top of casing	273.4	274.0	GPS	NAVD88	10	949202	Apr-2010	400	Single	60-80, 100-120, 140-160, 180-200, 220-240, 260-280, 300-320, 340-360, 380-400
NVF-Yountville	2-2.01	unk (179)	2014	SA	1	TBD	Irr	Active	38.377940	122.334177	GPS	NAD83	150	top of casing	74.3	72.0	GPS	NAVD88	10	323994	Jul-1997	255	Single	55-255
NVF-Yountville	2-2.01	unk (180)	2014	SA	1	TBD	Dom	Active	38.375357	122.336649	GPS	NAD83	150	top of casing	76.9	76.0	GPS	NAVD88	10	unk	unk	TBD	Single	TBD
NVF-Napa	2-2.01	unk (182)	2014	SA	1	TBD	Dom	Active	38.354305	122.291443	GPS	NAD83	150	top of casing	48.1	45.0	GPS	NAVD88	10	unk	Oct-1971	400	Single	100-400
NVF-MST	--	unk (191)	2014	SA	1	TBD	Dom	Active	38.340202	122.271438	GPS	NAD83	150	top of casing	63.1	63.0	GPS	NAVD88	10	unk	unk	150	Single	TBD

Appendix A
Napa County CASGEM Network Well Information

General Well Information									Well Location					Well Elevation						Well Construction				
Napa County Subarea	DWR GW Basin Number[1]	State Well Number (County Well ID)	Water Level Period of Record	Msmt Frequency	# of Msmts	Aquifer Designation	Well Use	Operational Status	Latitude	Longitude	Coordinate Method	Horizontal Datum	Coordinate Accuracy (feet)	RPE Description	Reference Point Elevation (feet)	Ground Surface Elevation (feet)	Elevation Method	Vertical Datum	Elevation Accuracy (feet)	Well Completion Report Number	Date	Well Depth (feet)	Well Completion Type	Screened Interval (feet)
Carneros	2-2.03	unk (195)	2014	SA	1	TBD	Irr	Active	38.250044	122.325496	GPS	NAD83	150	top of casing	94.8	94.0	GPS	NAVD88	10	unk	Sep-1983	TBD	Single	TBD
Napa River Marshes	2-2.03	unk (200)	2014	SA	1	TBD	Irr	Active	38.219940	122.327430	GPS	NAD83	150	top of casing	15.7	14.0	GPS	NAVD88	10	unk	unk	TBD	Single	TBD
Napa River Marshes	2-2.03	unk (201)	2014	SA	1	TBD	Irr	Active	38.218668	122.338546	GPS	NAD83	150	top of casing	50.4	50.0	GPS	NAVD88	10	unk	unk	TBD	Single	TBD
Angwin	--	unk (202)	2014	SA	1	TBD	Dom	Active	38.568436	122.448517	GPS	NAD83	150	top of casing	1728.2	1728.0	GPS	NAVD88	10	384966	Nov-1991	280	Single	100-280
NVF-Calistoga	2-2.01	unk (208)	2014	SA	1	TBD	Dom	Active	38.542145	122.512863	GPS	NAD83	150	top of casing	503.4	502.0	GPS	NAVD88	10	unk	unk	320	Single	300-320

Definitions: SA (Semi-annual); Dom (Domestic); Irr (Irrigation); Stk (Stock); Unus (Unused); Unk (Unknown); TBD (to be determined); Qal (Quaternary Alluvium); SV (Sonoma Volcanics); QTh (Quaternary and Tertiary Huichica formation)

[1]DWR Groundwater Basin Number: 2-2.01 (Napa-Sonoma Valley GW Basin, Napa Valley Subbasin), 2-2.03 (Napa-Sonoma Valley GW Basin, Napa-Sonoma Lowlands Subbasin)

APPENDIX B

Napa County Procedure for Measuring Groundwater Levels

NAPA COUNTY PROCEDURE FOR MEASURING THE DEPTH TO WATER IN MONITORING AND PRODUCTION WELLS

Purpose

To obtain an accurate dated and timed measurement of the static depth to water in a well that can be converted into a water level elevation in reference to a commonly used reference datum (e.g., NAVD 1988). In this context, static means that the water level in the well is not influenced by pumping of the well. For comparability, measurements should be obtained according to an established schedule designed to capture times of both highest and lowest seasonal water level elevations. Also for comparability, measurements during a particular field campaign should be obtained consecutively and without delay within the shortest reasonable time.

Measurement Procedure

- If a well is being pumped, do not measure; return later, but not sooner than 60 minutes and preferably after 24 hours (see below "Special Circumstances" for additional instructions).
- Turn on water level indicator signaling device and check battery by hitting the test button.
- Remove access plug or well cap from the well cover and lower probe (electric sounder) into the well.
- When probe hits water a loud "beep" will sound and signal light will turn red.
- Retract slightly until the tone stops.
- Slowly lower the probe until the tone sounds.
- Note depth measurement at rim (i.e., the surveyed reference point for water level readings) of well to the nearest 0.01 foot and rewind probe completely out of well.
- Remove excess water and lower probe once again into well and measure again.
- If difference is within ±0.02 foot of first measurement, record measurement.
- If difference is greater repeat the same procedure until three consecutive measurements are recorded within ± 0.02 foot.
- Rewind and remove probe from well and replace the access plug or well cap in the well cover.
- Clean and dry the measuring device/probe and continue to next well.

Special Circumstances

Oil Encountered in Well

If oil is detected in the well structure, the depth to the air-oil interface is measured. To obtain such a measurement, the electric sounder is used similar to the way chalked steel tapes were traditionally used for depth-to-water measurements.

1. Lower the cleaned probe well below the air-oil interface (e.g., 1 foot). Read and record the depth at the reference point (since this depth is chosen somewhat arbitrarily by the field technician, an even number can be chosen, e.g., 37.00 feet). This measurement is the length of cable lowered into the well and corresponds to a line that the oil leaves on the probe or cable (i.e., the oil inundation line). Above this line, smudges of oil may appear on the cable. Below this line, the cable/probe is completely covered with oil. If the probe is lowered too far, completely penetrates the oil, and is far submerged in the water below the oil, parts of the probe/cable below the oil inundation line may also appear smudgy.
2. Retrieve probe, identify and record the oil inundation line on the cable (e.g., 2.72 feet). This measurement does not reflect the thickness of the oil. It reflects the length of the cable below the air-oil interface.
3. Compute the depth to oil by subtracting the length of line below the air-oil interface from the corresponding measurement at the reference point: Depth to oil = 37.00 feet – 2.72 feet = 34.28 feet.

Since oil has a slightly smaller density than water, a depth-to-oil measurement will always be smaller than a corresponding depth-to-water measurement in the same well if oil were not present. Depth-to-oil measurements yield a reasonable approximation to depth-to-water measurements unless the oil thickness is great. For each foot of oil in the well casing, the depth-to-oil measurement will be approximately 0.12 foot smaller than a corresponding depth-to-water measurement if oil were not present.

Pumping Water Level on Arrival

If well is being pumped, do not measure. Return later when the water level has stabilized. Using past field notes, the field technician will use his/her experience to determine the appropriate duration necessary for static measurements. Upon returning to the well site (at a location where pumping was previously noted on the same day), the technician will measure the water level. The technician will have available historical water level data to determine whether the measurement is consistent with past measurements. If the initial measurement appears anomalous, the technician will measure water levels every 10 minutes over a period of 30 minutes.[8] If measurements vary significantly from past measurements (taking into account seasonal variations), the technician will note the circumstances (i.e., the date and time when the well was first visited, total time it was pumping (if known), when it was shutoff, when the technician returned, and subsequent water level measurements [on the same day, or as the case may be based on experience, the day immediately following]). Subsequent consideration of pumping effects at a site-specific well location will be addressed as necessary.

[8] During this period, if the groundwater level difference is greater [than +/- 0.02 feet], repeat the same procedure until three consecutive measurements are recorded within ± 0.02 foot.

Recordation

1. Name of field technician
2. Unique identification of well
3. Weather and site conditions (e.g., clear, sunny, strong north wind, intense dust blowing over wellhead from nearby plowed field; dry ground, easy access)
4. Condition of well structure (e.g., well cap cracked – replaced with new one; wasp hive between well casing and well housing; no action, discuss with project manager)
5. Time and date of depth-to-water reading
6. Any other pertinent comments (e.g., sounder hangs up at 33 feet, thus no measurement; or: fifth measurement of ~55.68 feet in a row…residual water in end cap?; or: oil in well…measurement is depth to oil; or: intense sulfur odor upon opening well cap; or: nearby (west ~100 feet) irrigation well pumping)

APPENDIX 5C

Groundwater Sample Collection Procedures from Wells Equipped with a Pump

GROUNDWATER SAMPLE COLLECTION PROCEDURES FROM WELLS EQUIPPED WITH A PUMP

Groundwater sample collection conducted in accordance with the procedures outlined below will help ensure consistent collection of representative samples and will minimize the introduction of factors that can skew laboratory analytical results and interpretation of the water quality data.

1. Well Sampling Equipment

The following equipment is used during sampling of wells:

- Electric or acoustic depth to water level measurement instrument
- Oakton T-100 or comparable instrument (turbidity)
- YSI 556 MPS or comparable instrument (EC, pH, temperature, DO, ORP)
- Spare batteries for all instruments
- Clean 500 mL beaker or flow-through cell
- Disposable gloves (latex or nitrile)
- Sample bottles supplied by lab certified contracting laboratory
- Ice chest (clean)
- Ice
- Distilled water
- Indelible pen (Sharpie)

Verify that all equipment is functional and in good working order before heading into the field.

2. Field Forms

The following forms shall be utilized for well sampling:

- Chain of Custody forms – Pre-printed or laboratory supplied
- Well Purge and Sampling Field Form

Field forms and Chain of Custody forms shall be filled out for each well site event.

3. Water Sample Collection Preparations

3.1 General Preparations

A. Technician shall review the previous sampling event field forms to familiarize themselves with each sampling location, any special procedures, the sample collection point, unusual or unique conditions, or potential hazards.

B. Technician shall contact well owners at least one week prior to the sample event, if possible, to coordinate sample collection date and time. Well owners are not required to be present for sample collection.

C. Technician shall contact the appropriate certified laboratory at least one week prior to sampling to arrange pickup/delivery of all required sample bottles, including one complete set of extra bottles. Sample containers with preservation appropriate for the analyses to be performed

shall be provided by the contracting certified laboratory. Arrangements for sample drop off times and locations for each sampling day shall also be made.

D. Technician shall assemble project information packet including these procedures, event objectives, water quality analysis to be performed and list of appropriate sample containers, map(s) to well site(s), contact information for well owner(s), project Health and Safety Plan, and project emergency contact list.

It is recommended that any work that can be conducted prior to arrival at a well site, including filling out site information on field forms, labeling bottles, calibrating instruments, cleaning equipment, etc., should be.

3.2 Field Instrument Calibration and Maintenance

The field instrument(s) for measurement of EC, temperature, pH, ORP, and DO shall be calibrated prior to sampling each day that sampling is conducted. Calibration of all field instruments shall be conducted according to manufacturer-provided procedures. Calibration of field instrument for measurement of pH shall include a 3-point calibration using 4, 7, and 10 pH standards. Field instrument for measurement of EC shall be calibrated for the range of EC values expected and recalibrated to the appropriate range whenever conductivity of a well is found to be outside of the manufacturer-recommended range for the current calibration standard.

The field instrument used to measure turbidity shall be calibrated daily according to manufacturer-provided procedures.

Calibration records shall be maintained for each instrument and shall be kept with the instrument. If any instrument is recalibrated in the field, it shall be noted on the field form along with the reason for recalibration.

All field instruments shall be stored in their manufacturer-provided cases at all times unless immediately in use.

3.3 Field and Chain of Custody Forms

A. Field Forms – A field form shall be filled out for each well site and event. All site/well information required on the field form will be filled in completely upon arrival at the well site. A GPS device will be used to record the well location coordinates at each site visit.

All observations, measurements, results of tests, instrument calibration, or issues of concern shall be noted on the field form. The condition of the well shall be inspected for evidence of damage, contamination, tampering and/or vandalism and noted on the field form. Anything that is or has the potential to affect the ability to collect water levels or water samples shall be noted on the field form.

B. Chain of Custody (COC) Forms – The COC form is utilized to record sample identification numbers, type of samples (matrix), date and time of collection, preservation method, and analytical tests requested. In addition, times, dates, and individuals who had possession of the samples are documented to record sample custody.

COC forms shall be filled out completely at the time of sample collection. A COC form shall accompany collected samples at all times. Technician shall sign the COC upon relinquishing the samples to laboratory or courier. A laboratory representative or courier shall sign the COC upon accepting the samples and provide a copy of the COC to the technician.

All field forms and Chain of Custody forms shall be filled out completely before leaving each site.

4.0 Water Level Measurements

Prior to any sampling event, the water level (static only) in the well shall be measured, when possible. If a well is actively pumping at the time of the event, no attempt should be made to measure the water level and this should be noted on the field form along with the time (or duration) since pumping started, if known.

The water level in the well shall be measured using an electric or acoustic sounder. The depth to water shall be measured relative a specified reference point at the surface. The reference point shall be defined/described on the field form. Every effort will be made to consistently measure water level to the same reference point. Depth to water measurements shall be recorded to the nearest 0.01 foot and immediately recorded on the field form.

5.0 Purging

Prior to sampling a well, the well shall be purged to ensure that any water collected for analysis is representative of groundwater. Typically (if the well is not actively pumping upon arrival on-site), a well is considered purged after discharging three wet casing volumes of water or after water quality field parameters (temperature, pH, conductivity) have stabilized. Generally, a well that has been pumping between 30 and 60 minutes can be considered purged. If a well is pumping upon arrival on-site, the parameter stabilization method should be followed to determine when the well is ready for sampling. For domestic wells not actively pumping upon arrival on-site, if purging three well casing volumes is not feasible but the well has recently been actively used, the parameter stabilization method can be followed to determine when the well is ready for sampling.

5.1 Three Casing Volume Purge Method - Calculate the required purge volume using the well depth and diameter, measured water level, and casing volume information included on the field form. Pump the well until the calculated volume of water has been discharged.

5.2 Parameter Stabilization Purge Method - With the well pumping, collect discharge water in a beaker (minimum volume of 0.5 liter) or direct flow to a flow-through cell to allow measurement of pH, conductivity, and temperature with a portable field instrument(s). Field parameters are considered stable when three successive parameter measurements, spaced 2-minutes apart, meet the following criteria:

- Electrical conductivity (EC) should vary by no more than 5%.
- pH should vary by no more than 0.1 pH unit.
- Temperature varies by no more than 0.2°C (0.32°F).

All parameter measurement results, time of measurements, pumping duration, flow rate, discharge volume, and observations shall be recorded on the field form.

6.0 Sample Collection

Procedure

1. Once well purging is complete (if required), keep the sample tap of the well open
2. Verify that all the sample bottles required for the sample event are present, that the bottles have correct labels, and that all bottles are new, in good condition, and sealed.
3. Fill out sample bottle labels include the following information:

    - Sample ID
    - Technician's initials
    - Date and time of collection
    - Analyses to be conducted
    - Type of preservative used (if any)

    Do NOT include identification of the well owner or the well location.

3. Measure field water quality parameters using a flow-through cell or using a beaker designated for this purpose, when appropriate. Record all field water quality parameters on the field form along with any other observations. Field water quality parameters include the following: **pH, temperature, conductivity, ORP, dissolved oxygen**.
4. Place all sample bottles to be filled in a clean location, near the sample tap, but out of the way of any splashing water. Do not open bottles.
5. Adjust sample tap to a low rate to avoid splashing bottles.
6. Put on clean gloves.
7. For each sample bottle in turn: open, fill completely (minimizing headspace), close firmly, place in ice chest immediately.
    - Do not hold bottle lid upside down
    - Immediately cap sample bottle lid after sample is collected.
    - Some bottles may have acidic or other preservative in them, avoid spillage or splashing of the preservative.
    - Ensure bottles are completely covered in fresh ice.
8. If a sample bottle is spilled, if bottle or lid is dropped, or the sample or sample container is otherwise compromised, a replacement bottle shall be used to collect a replacement sample as follows:
    a. Collect replacement sample as above, place in ice chest, proceed with any other samples.
    b. Fill out new bottle label after all samples are collected, dry the replacement bottle with a clean cloth, attach label, replace bottle in ice chest.
    c. Note the incident on the field form**.**
9. Close sample tap.
10. Rinse all equipment with distilled water and stow in appropriate containers.
11. Verify that all fields on field form and COC are completed.
12. Return all hoses, doors, gates, or other well-owner equipment to the state they were in upon arrival.

13. If possible, all filled sample bottles and accompanying COC's shall be transported to the contracted certified laboratory or transferred to a courier at the end of each sampling day. Be aware of sample storage temperature and hold times when considering the transportation to the laboratory for analysis. Samples must remain on ice during the storage and transportation period.

Well Purge and Sampling Field Form

Well ID:_____ **Site Name:**_____ **Site Location:**_____

Date:_____ **Arrival Time:**_____ **Technician:**_____ **Event: Water Level/Sampling**

GPS Lat:_____ **GPS Long:**_____ **Well Pumping/Not Pumping Weather:** _____

Location & description of collection point. Use location from previous sample events if possible. If not, explain:

_____

Condition of Sample Location:_____ **Wellhead:**_____ **Seal/Pad:**_____

Water Level Reference Point:_____

(A) TOTAL WELL DEPTH (ft):	(B) SWL (ft):	CASING VOLUME PER FOOT (gal): (2": 0.16) (4": 0.65) (5": 1.0) (6": 1.47) (8": 2.61) (10": 4.08) (12": 5.88) (14": 8.0) (16": 10.45) (18": 13.2) (20": 16.32)
(D) CASING VOL (gal/ft):	CASING DIAMETER (in);	

(A) _____ - (B) _____ = (C) _____ STANDING WATER COLUMN (ft); (C) _____ x (D) _____ = (E) _____ WET CASING VOLUME (gal)

(E) _____ x 3 = _____ MINIMUM PURGE VOLUME (gal)

Stability is achieved when pH varies by 1 SU or less over 2 minutes, AND EC by 5% or less over 2 minutes, AND Turbidity is below 10 NTU

Clock Time	Pumping Time (min)	Flow Rate (gpm)	Cumulative Flow (gals)	Temp (°C)	pH	EC (µs/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Observations (color, odor, sediment, etc.)

Sample Time	Sample ID	Bottle Size (mL)	Bottle Type (Amber Glass, Opaque Plastic, Translucent Plastic), Preservative	Analyte(s)	Sample Type (Blank, Duplicate)

Notes: _____

_____

_____

_____

CHAIN OF CUSTODY ID No. _____ Page 1 of ___

Project Contact (Hardcopy or PDF To):		California EDF Report? ☐ Yes ☐ No
Company / Address:		Sampling Company Log Code:
Phone #:	Fax #:	Global ID:
Project #:	PO #:	EDF Deliverable To (Email Address):
Project Name:		Sampler Signature:
Project Address:		

Chain-of-Custody Record and Analysis Request

Sample Designation	Sampling: Date	Sampling: Time	Container	Container	Container	Container	Container	Container	Container	Preservative: HCl	Preservative: HNO_3	Preservative: Sulfuric Acid	Preservative: ICE	Preservative	Matrix: Water	Matrix: Soil	Matrix: Air	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	Analysis Request	TAT	Special Instructions
																												☐ 12 hr ☐ 24 hr ☐ 48hr ☐ 72 hr ☐ 1 wk	Email Preliminary Results to:
																													Notes:

Relinquished by: (Sign/Print)	Date	Time	Received by: (Sign/Print)
Relinquished by: (Sign/Print)	Date	Time	Received by: (Sign/Print)
Relinquished by: (Sign/Print)	Date	Time	Received by: (Sign/Print)

Remarks:

Bill to:

For Lab Use Only: Sample Receipt

Temp °C	Initials	Coolant Present	Time	Therm. ID #
		Yes / No		